POWER PLANT ENGINEERING

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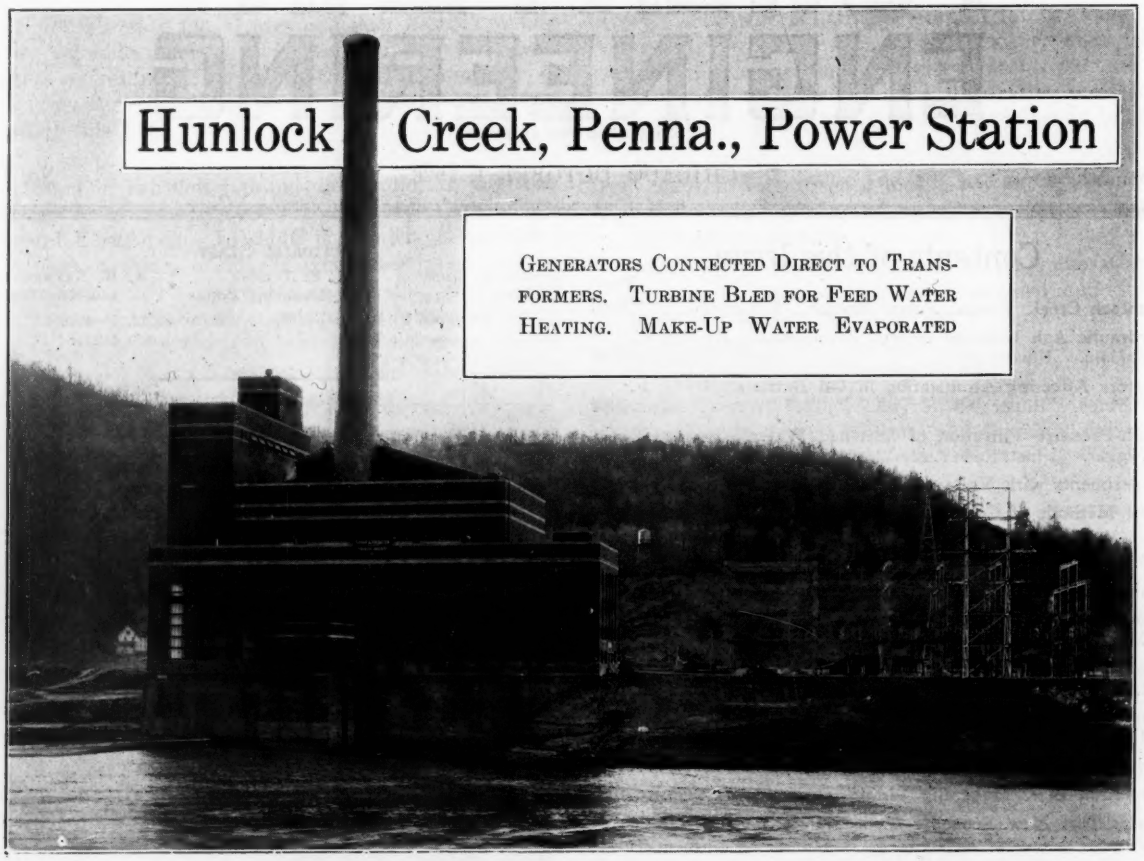
Archaeology 7000 A. D.

ENGINEERS, dealing with the cold realities of life, carrying the responsibilities of civilization on their shoulders, have little time to devote to the arts and it is with some trepidation that we reproduce the famous painting, which recently created such a furor in the Academy. From the brush of the famous Egyptian prophet-artist, Amen-Abu, born the son of a pipe-fitter in Rochester, the painting is the artist's conception of an archaeological excavation in the year 7000 A. D.

Possibly these fossil remains will be classified as reptilian Dinosaurs, probably of the sub-order Thermosaurus closely related to Ornithopoda "herbivorous, having hollow bones and a bipedal means of locomotion." At least we strongly suspect that the reptile pictured eats mineralized vegetable matter and that its only means of locomotion is by-pedal. In fact, if it were not for a certain poetic license which artists enjoy, we would openly accuse Mr. Amen-Abu of depicting a scene during the laying of steam heating mains which we describe elsewhere—but we hesitate to belittle another's efforts and reproduce the picture for those of our subscribers who ride art as a hobby and who, not winning Life's travel contest, cannot visit Paris to see the original.

Hunlock Creek, Penna., Power Station

GENERATORS CONNECTED DIRECT TO TRANSFORMERS. TURBINE BLED FOR FEED WATER HEATING. MAKE-UP WATER EVAPORATED



RECENTLY THE LUZERNE County Gas and Electric Corp. has placed in operation a new power station at Hunlock Creek, Pa., to care for the marked increase in the demand for electric power and light in the territory served by the corporation. About one-third of the northern coal fields of Pennsylvania lie within this territory, mining and preparation of anthracite being the chief industry in this district. The use of electric power in the collieries has grown so rapidly in the past few years that additional generating capacity is required to meet the demand.

Limitations of the site at Plymouth, Pa., where the corporation has a generating plant, were such that further expansion was considered uneconomical and, after consideration of possible sites for a new power station, a location was selected on the Susquehanna River, just below its junction with Hunlock Creek, which offers ample space for future expansion and for coal storage, with an adequate supply of water for condensing purposes.

General Features

Initial capacity of the new station was fixed at 20,000 kw. to meet the expected rate of growth in load with plans for future development to 190,000 kw. The present building is planned to provide space for two 20,000-kw. units and eight 1726-hp. boilers.

Close to the site is the anthracite field, which provides an adequate supply of low cost fuel in the finer sizes of screenings. Chain grate stokers of the forced draft type, were deemed most suitable for dependable operation with this grade of fuel since the pulverization of anthracite is in the development stage at present. The installation of economizers or air pre-heaters was investigated but the thermal economies would not warrant the additional capital investment.

This station is designed for operation at 375 lb. per sq. in. steam pressure and a total temperature of 700 deg. F. Gain in thermal efficiency by the use of a higher pressure was not great enough to warrant the additional investment which higher pressure would render necessary and the temperature of 700 deg. F. was selected as well within the safe limits of the materials available for equipment and accessories.

Analysis of the expected load conditions indicated that, from the point of overall efficiency, steam should be extracted from the turbine at two points for heating the feed water and all auxiliary equipment driven by electric motor, except in instances where steam turbine drive would be essential for flexibility of operation.

To secure a dependable source of power for the electrical auxiliaries, an auxiliary generator, driven by the main turbine, was deemed the most efficient means, since electricity can be produced with practically the same economy as in the main generator. A turbine-driven auxiliary or "house" generator is provided for use in emergency operation and for serving the auxiliaries, in the event that electric power is not available.

Step-up transformers are connected directly to the main generator without the use of a generator voltage bus at generated voltage. This arrangement provides a simple and flexible means of connecting to the 66,000-v.

transmission lines with a material reduction of capital investment.

Steel-Frame Building Construction

Steel frame construction is used with exterior walls of red brick, trimmed with cast stone, the roof and floors being of concrete and interior partitions of either concrete or tile. Steel stairs are provided for connecting the several levels in the power house. Ample skylights serve the boilers, turbine and control rooms insuring an abundance of natural light. The architectural treatment is simple, as shown by the view of the exterior, which presents a pleasing and dignified appearance quite consistent with the purpose of the structure.

Boiler house, turbine room, and a section allotted to administrative and electrical control purposes compose the building. The fourth floor of the control section serves as an operating room and the third floor is used for the load dispatcher and for a conduit room. On the second floor are offices for the chief engineer and the chief clerk, two bedrooms and a wash room. The first or main floor comprises a lobby and waiting-room, locker, toilet and shower room, a first-aid room and office for watch engineers. A mezzanine beneath the first floor provides room for storage batteries, motor generator, telephone equipment and general storage.

General arrangement of the structure and principal equipment is shown in the cross section, Fig. 1, which also indicates the wide variation in river levels. This variation governed the design of the turbine room as

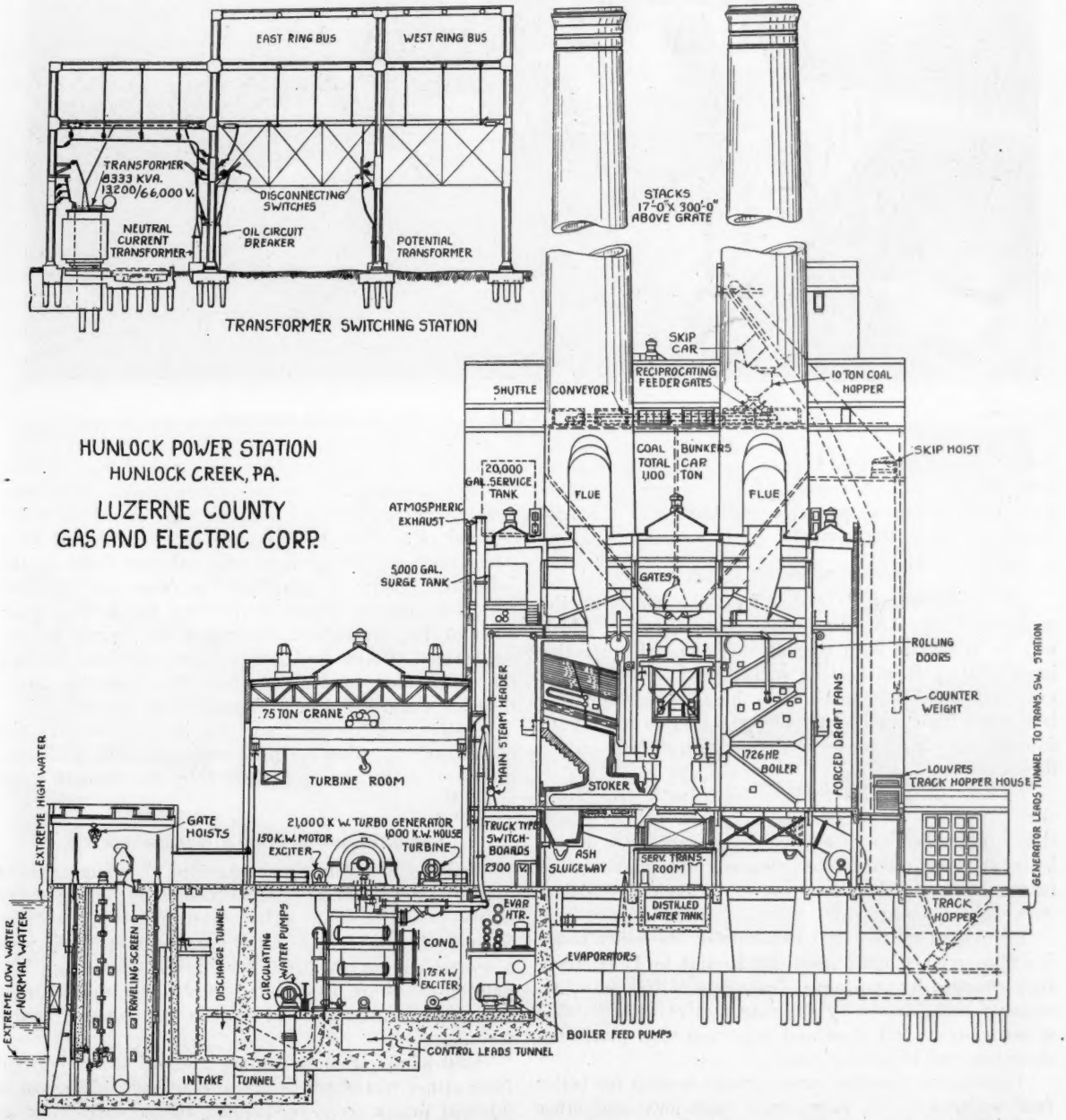


FIG. 1. BOILERS, GENERATORS AND SWITCH-HOUSE ARE ABOVE HIGH WATER. COAL IS BUNKERED OVERHEAD. STACKS CARRIED ON STEEL STRUCTURE

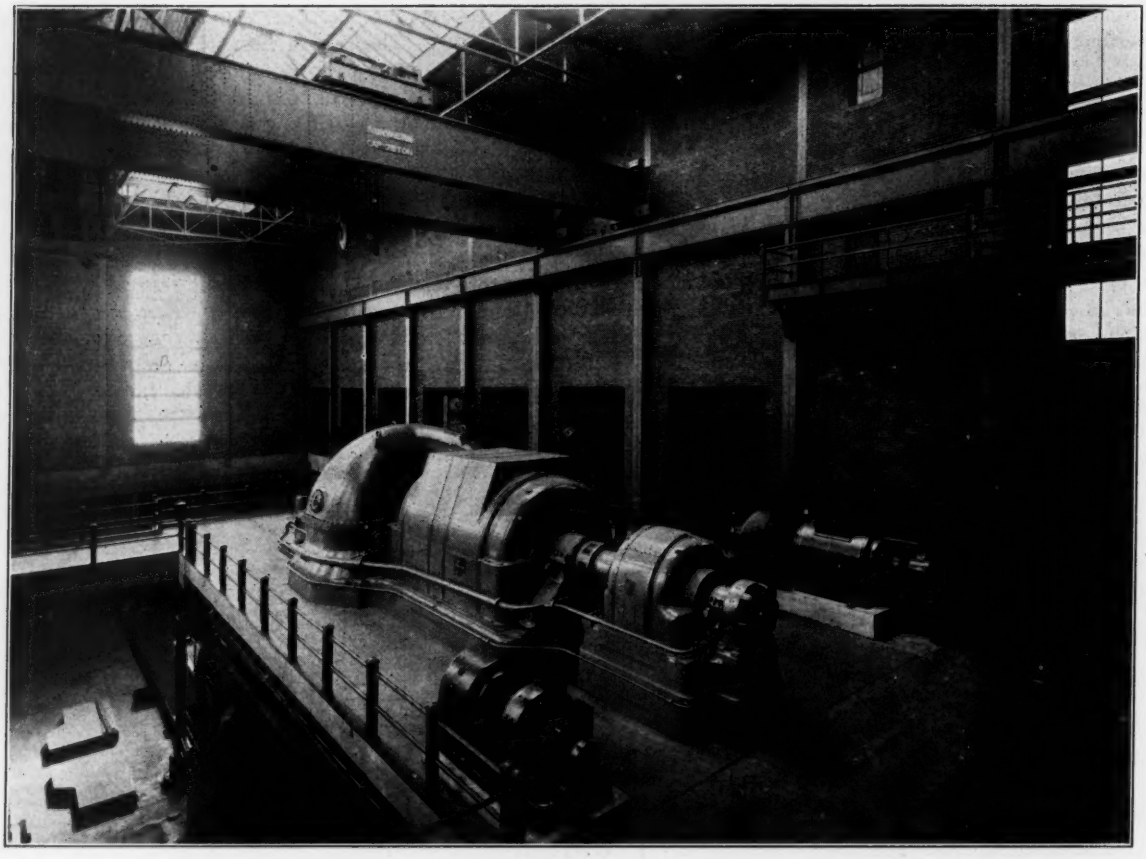


FIG. 2. AUXILIARY POWER GENERATOR IS DRIVEN BY MAIN TURBINE

the generators are placed beyond the reach of the highest flood which has been recorded. The condenser pumps are located just above normal water level, so as to reduce the total head on the pumps.

Stokered Boiler Plant

Three Babcock & Wilcox, water-tube boilers of the cross-drum type are installed at present, two of which will be in service with normal operation. Each boiler has 17,260 sq. ft. of heating surface with a double deck arrangement of 4-in. tubes, 20 ft. long. The lower deck is 6 tubes high and the upper one 14 tubes high, with superheater of the convection type, located between the decks.

Stokers of the Harrington force-draft, travelling-chain type are provided, one for each boiler. Each stoker has 483 sq. ft. of effective grate surface, is driven by a constant-speed motor through a variable speed transmission, and has air supplied through a wind box with eight compartments.

Supported by the steel structure of the boiler house is a reinforced concrete stack, 300 ft. high by 17 ft. diam. supplemented by two forced draft fans of 150,000 c.f.m. capacity each, driven by slip-ring motors with variable speed control. All flues and ducts are steel plate construction with expansion ribs.

Condensate from the main turbine is used for boiler feed water with the losses from blow-down and other causes made up by river water which has been evaporated. The condensate passes from the condenser through the oil cooler and air ejector condenser, whence it flows through two closed heaters and a gland condenser, the temperature having been raised to about 230 deg. F. This heated condensate is collected in a surge tank of 5000-gal. capacity, thence flows to the boiler feed pumps by gravity. The surge tank is sealed with low-pressure steam, to prevent the admission of air and the consequent absorption of oxygen by the condensate. Boiler feed pumps force the water through the evaporator condenser, where the temperature is raised to about 270 deg. F., thence to the boilers.

Steam is extracted from the main turbine at the eighth stage at absolute pressure under full load conditions of 26 lb. per sq. in. and from the eleventh stage at 5.7 lb.

Steam Piping Is Single Header System

Boilers and turbines are connected by a single header piping system, which is supplemented by an auxiliary header with connections to all steam-driven auxiliary equipment. Important valves are motor operated with a centralized control board for emergency closing. Expansion bends are provided at suitable points and spring supports are used to avoid stresses on connected equipment.

Coal handling equipment is designed to receive coal from either motor trucks or railroad cars. The coal is dumped into a receiving hopper, thence carried by an apron conveyor to two counterweighted skip hoists, which, in turn, deliver the fuel to a shuttle belt conveyor

above the 1100-t. bunker. From the bunker coal is fed to a travelling weigh larry which distributes the fuel to the stoker hoppers. The coal handling equipment has a capacity of 100 t. an hour.

About 20,000 t. of coal can be stored adjacent to the station, coal being reclaimed from storage by a locomotive crane and bottom dump railroad car. A four-wheel saddle tank locomotive is used for handling cars to and from the storage yard.

Turbine Generators and Condensers

The main turbine is a single-cylinder, 14-stage machine, direct connected to a 20,000-kw., 13,800-v. generator and to a 1000-kw., 2300-v. auxiliary generator. It is designed to operate at 350 lb. per sq. in. with a total temperature of 700 deg. F. The generators are wound to supply 3-phase, 60-cycle current. A 150-kw., motor-driven exciter is the normal source of 250-v. excitation, reserve capacity being provided by a 175-kw. exciter duplex driven by motor or by steam turbine.

Serving the main turbine is a two-pass, two-compartment, surface condenser, with 37,112 sq. ft. of tube surface. Circulating water is drawn from the river, through travelling screens, by two motor-driven centrifugal pumps of 20,000-gal. capacity each, which can be operated at variable speed to suit the changing level of the river.

Electric Auxiliary Drive

Adoption of electrically-driven auxiliaries made it necessary to provide a reliable power supply for these auxiliaries. An auxiliary generator, direct-driven by the main turbine, was deemed the most efficient means, with a separate turbine-driven auxiliary generator of 1000-kw. capacity for use in emergency operation and for starting the station in the event electric power is not available.

All station auxiliaries are driven by alternating-current motors except one exciter, one boiler feed pump, and one fire pump, for use in emergencies, these being turbine-driven. The motors driving the exciters for the main unit have differential but no overload protection.

Auxiliary generators feed a 2300-v. ring bus from which the larger motor-driven auxiliaries are supplied. The smaller auxiliaries are wound for 440 v. and supplied from two separate busses, one of which serves the turbine room and the other the boiler house, each being connected to the 2300-v. bus through two 200-kv.a. transformers.

Miscellaneous Equipment

To serve the turbine room is a four-motor travelling crane of 75-t. capacity, and a railroad connection is made so that equipment and supplies may be handled from railroad cars by this crane.

Compressed air mains throughout the station are fed by a compressor with a capacity of 430 c.f.m.

In the lubrication system of the main turbine is installed a gravity filter, with storage for clean and filtered oil and a centrifugal purifier for general station use.

Fire protection is by means of a turbine-driven fire pump with a capacity of 1500 g.p.m. and a system of fire mains extending throughout the station with hose stations located at suitable points.

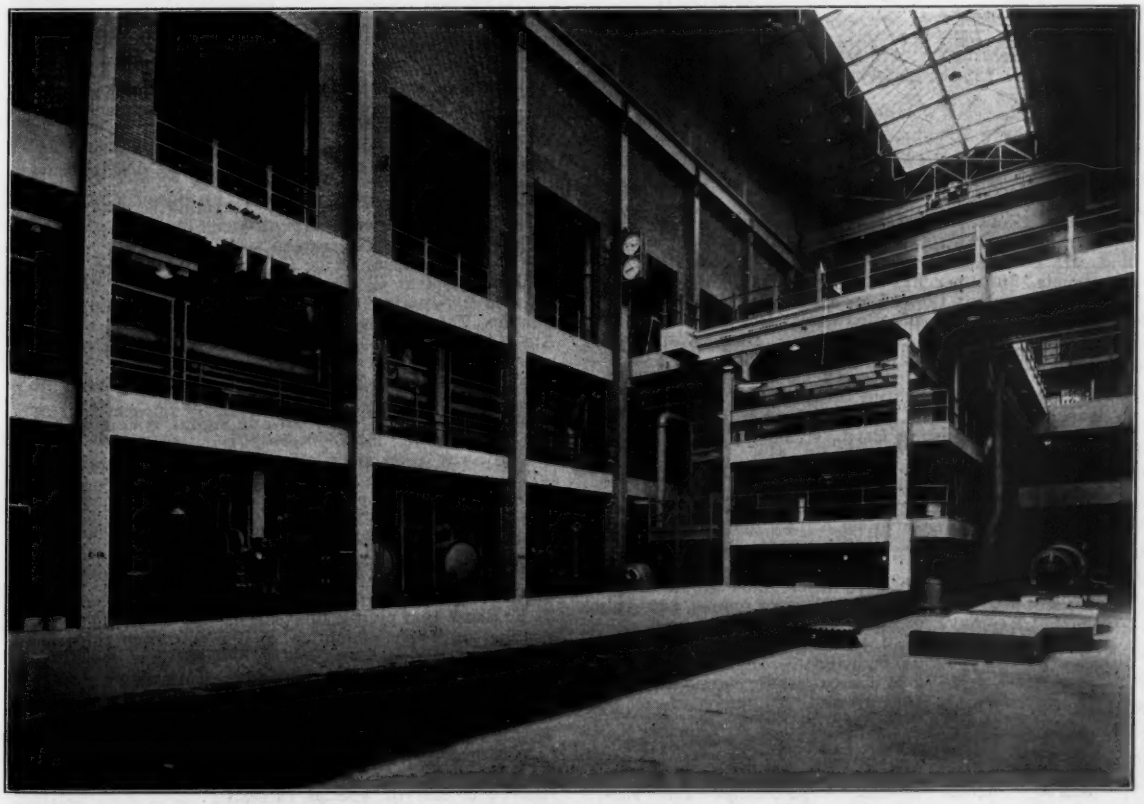


FIG. 3. CONDENSER AND FEED WATER EQUIPMENT ARE CONVENIENTLY GROUPED

Principal Equipment at Hunlock Power Station

Boilers, Stokers and Auxiliaries

3 Babcock & Wilcox Co., 17,260 sq. ft. water-tube boilers, working pressure 375 lb. per sq. in.
3 Babcock & Wilcox Co. convection type superheaters.
3 Riley Stoker Corp., 483 sq. ft. chain grate stokers, forced draft type, driven by 3 10-hp., 440-v. induction motors through Reeves variable-speed transmissions.
2 Cochrane Corp., closed tubular heaters and 1 gland steam condenser, 228,000 lb. water per hr. each.
2 Worthington Pump and Machinery Corp., 5-in., 5-stage, centrifugal boiler feed pumps, 750 g.p.m. capacity each, and 1 5-in., 4-stage, centrifugal boiler feed pump, 500 g.p.m. capacity. The 5-stage pumps are driven by 2 300-hp., 2300-v., slip-ring induction motors; the 4-stage pump by a Westinghouse 190-hp. turbine.
1 Griscom-Russell Co., 2-effect evaporator, 18,000 lb. water per hr. capacity.
1 General Concrete Construction Co., reinforced concrete stack, 17 ft. internal diameter, 300 ft. high.
2 American Blower Co., double width, 60-in. diameter, forced-draft fans, 150,000 c.f.m. capacity each, against 5-in. water pressure, driven by 2 200-hp., 2300-v., slip-ring induction motors.

Turbines, Condensers and Auxiliaries

1 General Electric Co., 21,000-kw. extraction type turbine, driving a 20,000-kw., 13,800-v. generator and a 1000-kw., 2300-v. auxiliary generator. Turbine is 14-stage, 1800 r.p.m. machine, designed for 350 lb. operating pressure with total temperature 700 deg. F. Generators are 3-phase, 60-cycle units.
1 Worthington Pump and Machinery Corp., surface condenser, 37,112 sq. ft. cooling surface; with 2 30-in. volute centrifugal circulating water pumps, 20,000 g.p.m. capacity each, driven by 2 200-hp., 2300-v., slip-ring motors; with 2 6-in., 2-stage centrifugal condensate pumps driven by 2 60-hp., 2300-v., squirrel cage motors; with 4 2-stage air ejectors, 15 c.f.m. capacity each, arranged in two units each with common surface intercooler and after condenser.
1 General Electric Co., 150-kw., 250-v. exciter driven by a 225-hp., 2300-v. motor.
1 General Electric Co., 175-kw., 250-v. exciter driven by a 260-hp., 2300-v. motor and a 233-hp. non-condensing turbine.
1 General Electric Co., 1000-kw., 2300-v. house generator driven by a 1330-hp. non-condensing turbine.

Coal and Ash Handling

1 The Browning Crane Co., 8-wheel, 20-t. steam driven locomotive crane.
1 Vulcan Iron Works, 4-wheel saddle tank locomotive with 16 by 24-in. cylinders.
2 R. H. Beaumont Co., automatic counterweighted skip hoists, 50-t. per hr. capacity each, motor operated.
1 R. H. Beaumont Co., 24-in. shuttle belt conveyor.
1 Stephens-Adamson Mfg. Co., weigh larry, 15-t. capacity.
3 The Baker Dunbar Co., cast iron, tile-lined ash hoppers with hydraulically operated gates.
1 The Baker Dunbar Co., cast-iron sluiceway, with special cast-iron liners, 160 ft. long.
1 General Equipment Co., 50-t., bottom-dump coal car.
3 Girtanner Engineering Corp., steam-jet cinder removal equipments.

Miscellaneous Equipment

1 Northern Engineering Works, 75-t., 4-motor traveling crane.
1 Ingersoll-Rand Co., 13 by 18 by 12-in., 2-stage air compressor.
3 The Permutit Co., pressure filters, 500 g.p.m. each.
4 Morris Machine Works, vertical sump pumps, 300 g.p.m.
3 Ingersoll-Rand Co., 8-in. centrifugal service pumps.
1 Worthington Pump and Machinery Corp., centrifugal fire pump, 1500 g.p.m. capacity, driven by General Electric Co., 165-hp. non-condensing turbine.
1 S. F. Bowser & Co., Inc., oil filter equipment.
1 DeLaval Steam Turbine Co., oil purifier.

Electrical Equipment

4 8333 kv.a., General Electric Co., single-phase, 60-cycle, 38,100 (66,000 Y)-volt, high-tension and 13,800 (delta)-volt low-tension, self-cooled transformers.
5 600-amp., 7300-v., General Electric Co., 3-phase, 60-cycle, type KO-39 oil circuit breakers.
5 General Electric Co. switchboards as follows:
Main control switchboard consisting of 3-panel generator section, and 3-panel feeder section.
2300-v. truck type switchboard—16 panels.
440-v. switchboards consisting of 8 panels in boiler room section and 10 panels in turbine room section.
250-v. excitation switchboard of 9 panels.
125-v. battery control switchboard of 3 panels.
Electrical Development and Machine Co., indoor bus supports and disconnecting switches.
Delta Star Electric Co., outdoor disconnecting switches and bus supports.
The Kerite Insulated Wire & Cable Co., Kerite insulated cable.
The Esterline Co., graphic recording instruments.
The Leeds and Northrup Co., temperature recorders.
Carleton-Mace Engineering Corp., lighting switchboards.
Westinghouse Electric & Mfg. Co., automatic control for boiler feed and forced-draft fan motors.
Ohio Brass Co., suspension insulator strings.
Kellogg Switchboard & Supply Co., switchboard for high line telephones.
Chas. Cory & Sons, Inc., annunciator.
Mutual Electric Co., safety switches.
The National Co., cell door hardware.
Screw Machine Products Co., automatic telephone system.
Moloney Electric Co., lighting transformers.
The Electric Storage Battery Co., control storage battery.

Accessories

Diamond Soot Blower Corp., soot blowers.
American Arch Co., stoker arches.
George Allen & Son, header blocks.
Coatesville Boiler Works, blow-off, surge and storage tanks.
Seaboard Refractories Co., fire brick.
U. S. Refractories Corp., fire brick.
Elk Fire Brick Co., fire brick.
Crescent Refractories Co., fire brick.
The Engineer Co., combustion control equipment.
Connery & Company, Inc., flues and ducts.
Northern Equipment Co., feed water regulators.
Worthington Pump and Machinery Corp., distillate evaporator feed.
Link-Belt Co., 2 10 ft. by 57-ft. traveling screens.
U. S. Rubber Co., rubber expansion joints.
S. Morgan Smith Co., screen well gates.
The Cutler-Hammer Mfg. Co., centralized valve control.
General Electric Co., generator air coolers.
Schutte & Koerting Co., turbine oil coolers.
Simplex Valve & Meter Co., Venturi meters.
American Schaeffer & Budenberg Corp., indicating steam and water gages.
Taylor Instrument Cos., indicating thermometers.
General Electric Co., steam flow meters.
Chas. Cory & Sons, Inc., turbine signal system and load demand indicators.
The Brown Instrument Co., recording gages and thermometers.
Warren Clock Co., synchronous clocks.
The Fairbanks Co., 20-t. truck scale.
Foamite Childs Co., Foamite engine.
Shoemaker Bridge Co., structural steel.
Reeves Pulley Co., speed transmissions.
Armstrong Cork & Ins. Co., insulating brick.
B. F. Shaw Co., piping fabrication and erection.
Pittsburgh Valve, Foundry & Const. Co., high-pressure flanged valves.
Schutte & Koerting Co., high-pressure screwed valves.
Reading Steel Castings Co., high-pressure flanged fittings.
R. B. Hobson, Holly drip receivers.
W. H. Nicholson Co., high-pressure traps.
Chapman Mfg. Co., compressor flanged valves.
E. B. Badger & Son, copper expansion joints.
Atwood & Morrill, special valves.

Indicating and recording instruments are provided so that a comprehensive system of station records can be maintained for checking operation and performance of the equipment.

On the lower floor of the boiler house a well equipped machine shop is installed to facilitate the making of emergency repairs.

The station is provided with an automatic intercommunicating telephone system for interoffice use and a high-tension transmission line telephone for connecting with sub-stations over metallic circuits carried on the tower lines. A separate connection to the local Bell Telephone System is also made.

Signal dials on pedestals provide communication between the operator in the control room and the engineer at the turbine throttle. Combination load-demand indicators are located at convenient points in the boiler and turbine rooms, also in some of the offices. The clock system is of the Warren synchronous type, connected to the station lighting circuits, with a master clock in the control room for regulating the frequency of the system.

Switchboard is Simplified

In order to simplify operation and reduce capital investment, the usual generator bus was omitted and the generator leads were connected direct to the step-up transformers which feed the 66,000-v. busses serving the transmission lines. This arrangement provides a simple, flexible design of electrical connections.

Control of the generators and feeder lines is centralized in a switchboard in the operating room. The switchboard has two sections, a generator section and one devoted to feeders, the two sections being arranged at right angles to each other, forming an L on two sides of the operating room. Indicating meters and control switches are mounted on the front panels of these boards and a corresponding rear panel accommodates recording meters, relays and accessory equipment.

All control wiring from equipment throughout the station is terminated at boxes in a conduit room located directly below the main switchboard, with all fuses, control busses and control sectionalizing switches located in these terminal boxes. The switchboard is connected with the terminal boxes by short runs of conduit through which the panel wiring is carried to the terminals in the boxes below.

The 2300-v. service is controlled by a truck type switchboard located adjacent to the turbine room. Each 440-v. bus is controlled by its separate switchboard located respectively in the boiler house and in the turbine room gallery.

Outdoor Substation

Connection from the generator to the 66,000-v. bus in the outdoor station is through a bank of three General Electric 8333-kv.a., oil-insulated transformers. The generator neutral is grounded through a nonautomatic circuit breaker and the neutral of the transformer bank is grounded by means of a disconnecting type switch with provision for the future installation of a neutral resistor. One spare transformer is provided for emergency connections.

This outdoor transformer and switching station is divided into two sections, one for the generator circuits, the other for the feeders. Main and auxiliary 66,000-v. busses serve both sections with provision for future connections to secure a double ring bus. Three 66,000-v. transmission lines are included in the initial installation, connected to the present distribution system through overhead lines and step-down substations. All equipment installed at present in the outdoor structure is for 66,000-v. operation but structural clearances are provided for ultimate 132,000-v. operation.

Larger equipment in this outdoor substation is mounted on concrete mats well above known flood levels. The smaller equipment and busses are supported by a galvanized steel structure with concrete footings. The general appearance of the outdoor station is shown in the accompanying head piece taken during the construction period. A standard gage railroad track with transfer truck facilitates removal and replacement of the transformer units, this track being connected to the turbine room so that the station crane can be used for dismantling the transformers. A system of oil piping and oil storage tanks is provided for both the transformers and the oil circuit breakers.

Main generator leads are brought to the outdoor station through a concrete tunnel, while all control leads for the electrically-operated breakers and other equipment in the outdoor substation are carried in a duct system from the control switchboard in the power house.

High-tension leads from the transformer bank are connected to the main 66,000-v. bus through an oil circuit breaker with differential relay protection and to the auxiliary bus through an oil circuit breaker with overload and differential protection. Each feeder line is arranged so that it may be connected either to the main 66,000-v. bus through an oil circuit breaker having overload protection or to the auxiliary bus through a disconnecting switch. Lightning arresters of the oxide film type protect the feeder lines.

Stone & Webster, Inc., designed and constructed the Hunlock Power Station under the direction of H. M. Blake, general superintendent of the American Gas Co, assisted by J. R. Buchanan.

In the annual report of the Federal Specifications Board, new engineering specifications are listed as follows: No. 314, Railroad track scales; No. 316, Steel blooms, billets, slabs and bars for reforging, carbon and alloy; No. 334, Fire clay; No. 335, Plastic fire clay refractories; No. 338, Ground cork for insulating purposes; No. 339, General specifications for metals; No. 342, Seamless brass pipe, iron pipe size, standard and extra strong; No. 343, Cast-iron soil pipes and fittings; No. 346, Non-renewable plug fuses; No. 347, Lap-welded and seamless steel boiler tubes; No. 348, Standard miscellaneous chain and attachments; No. 349, Lap-welded charcoal iron boiler tubes; No. 350, Concrete reinforcement bars; No. 351, Structural steel for bridges; No. 352, Structural steel for buildings; No. 369, Aluminum bronze castings; No. 370, Manganese bronze castings; No. 374, Condenser tubes and tubes for ferrule stock (Admiralty metal); No. 393, Unions, malleable iron and steel. Copies may be obtained from the Board or the Bureau of Standards, Washington, D. C.

Hydraulic Ash Disposal Proves Economical

System Developed by the Rockford Electric Co., During War Time Emergency, Is Simple and Economical. By Lee C. Shelain[1]

PERHAPS the development of the hydraulic ash disposal system of the Rockford Elec. Co., Rockford, Ill., can best be covered by the expression "Necessity is the Mother of Invention." Before the world war, ashes were taken from the hoppers of the boilers, carried in large two wheeled carts to bucket elevators and elevated to a concrete pit outside of the boiler room. From here they were loaded into coal cars, by a bridge crane, and disposed of by the railroad company free of charge.

When trouble began "over there" it was not long before the effects were noticed here. Transportation faculties were taxed to the limit so that car shortages and government orders made it impossible for the railroads to move the ashes as before. Temporary relief was afforded during the construction of Camp Grant when the government requisitioned all ash, or cinders, available for the construction of roads. This continued for about 2 yr. but upon completion of the cantonment, the electric company was again confronted by the same problem. After much study and patient experiment with an entirely new development Adam Gschwindt[2] and C. C. Taylor[3] perfected the present system to the point where they can forget that ashes exist.

Nine boilers with a total rating of 8178 b.hp. are now served. A concrete flume lined on the bottom with semi-circular vitrified tile passes directly beneath the ash pit gates. Ash and clinkers sluiced through a roll crusher are pumped by a dredge pump through 2100 ft. of bell and spigot pipe directly to the point of delivery. A plan of the system is shown in Fig. 1 and a view of the main flume in Fig. 2A. This flume, 15 in. wide with a depth increasing from 18 in. to 4 ft. in 153 ft., handles all the ashes from five boilers while a second flume 40 ft. long serves three 500-hp. boilers. The two join at point X, Figs. 1 and 2B, and discharge into a 30 by 30-in. single roll Jeffrey Crusher belted to a 15-hp. induction motor.

[1]Asst. Ch. Eng. Rockford Elec. Co.
[2]Gen. Mgr. Rockford Elec. Co.
[3]Chief Eng. Rockford Elec. Co.

Ashes Pumped Through 2100 Ft. of Pipe

At the gate of each ash pit a 3-in. pipe, discharging house service water at approximately 50 lb. pressure, is placed at such an angle that the water flushes the ashes toward the crusher as they drop, by gravity, from the boiler ash pit. Ash entering the flume is regulated by the operator so as to avoid stoppages. After being crushed ½ in. or smaller, the ashes fall to a small reservoir having a pipe connection to a 6-in. American Manganese Steel Co. dredge pump. This pump, driven by a direct connected 75-hp. induction motor, is capable of handling 900 g.p.m. of the mixture against a discharge head of 65 lb. Ashes flow to the pump by gravity with no appreciable head and are pumped through 2100 ft. of 6-in. bell and spigot pipe to the dumping ground.

Stacks Are Also Cleaned by Same Method

Duplicate pumping equipment has been installed for the single 1964-b.hp. boiler recently put in operation. No crusher is necessary as the boiler is equipped with clinker grinders. This pump discharges into the existing pipe line as but one pump is operated at a time. Each pump has a concrete expansion tank to receive any surplus water from quenching jets or overflow which might occur during the removal of ashes when the pump was working to capacity. Both stacks are also connected to the flume. This has proved to be an exceedingly handy and economical method of removing stack cinders.

Four 90-deg. bends are located in the 50 ft. of pipe nearest the pump. These are made of two 45-deg. ells which have been found to give longer service than a single 90 deg. elbow. With the exception of the discharge end which is moved about to allow even filling,

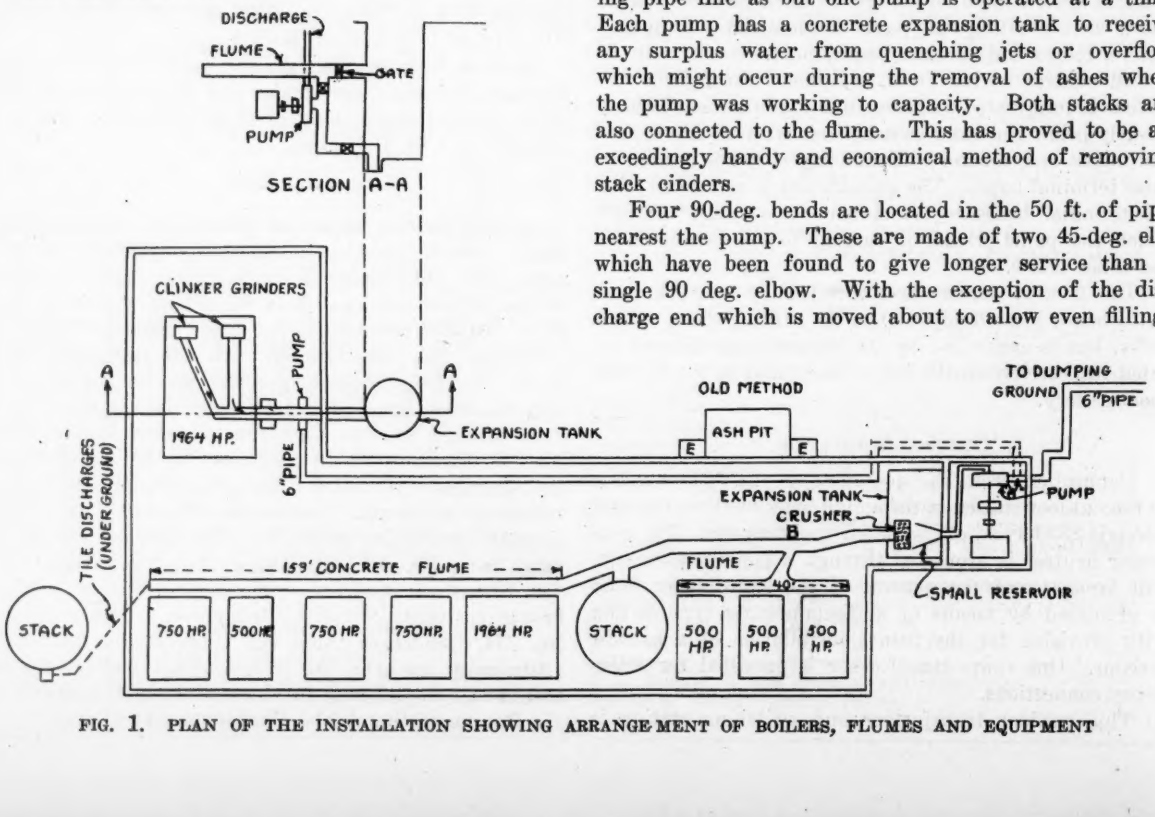


FIG. 1. PLAN OF THE INSTALLATION SHOWING ARRANGEMENT OF BOILERS, FLUMES AND EQUIPMENT

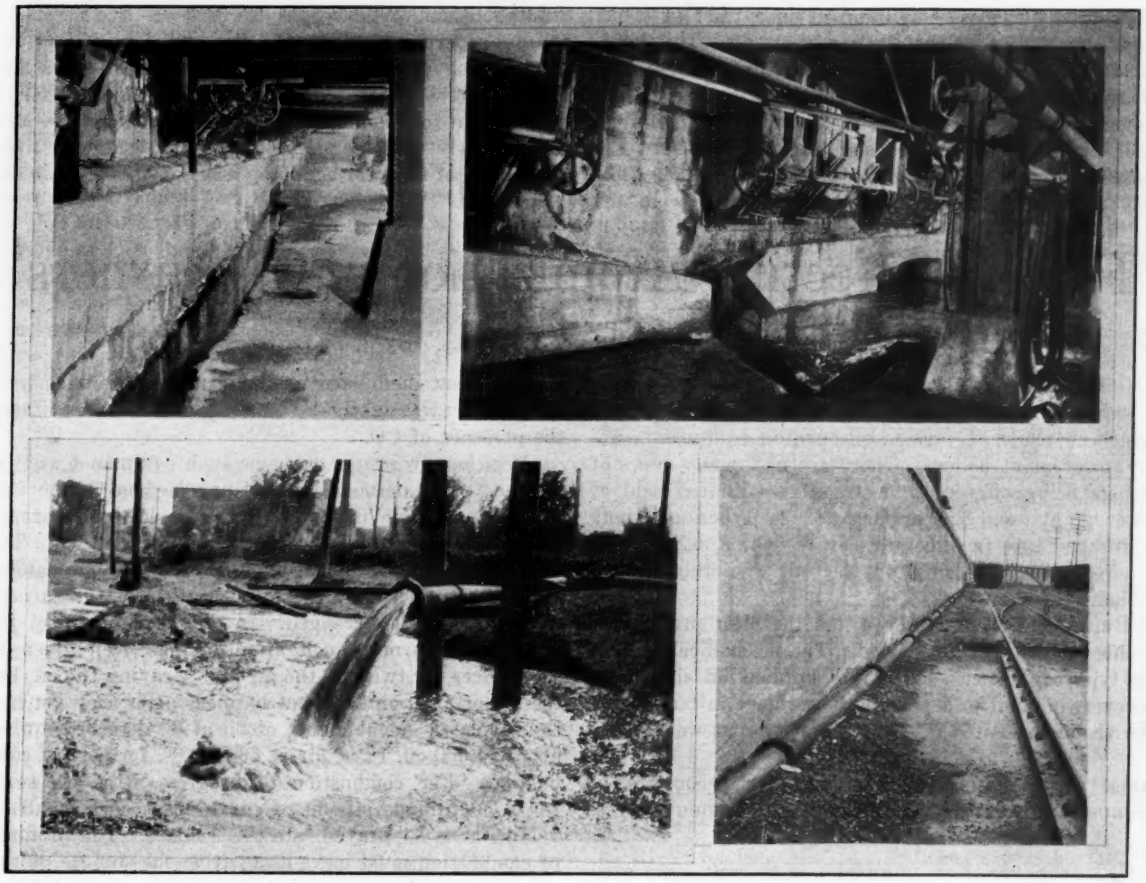


FIG. 2. VARIOUS VIEWS OF THE FLUMES AND PIPE LINE USED IN DISPOSING OF THE ASH

the remainder of the pipe is practically straight. Two sleeve type expansion joints are used and protection against freezing during cold weather is taken care of by inserting a 1-in. swing check valve at the highest point of the line. This valve, closed when ashes are being pumped, automatically opens when the pressure in the line drops to zero and allows the line to drain.

Two men per shift are required to operate the system, one man pulling ashes from the ash pits, one man operating the pump. At the present time ashes are pulled four times during the day and three times at night, each pull averaging one hour. The daily total disposal will average about 50 t. Between pulls the pump man has time for repairs to the equipment, inspection of the pipe line and other small duties, while the ash puller takes care of the reclaim coal and operates the soot blowers.

Predictions of Excessive Wear Proved Groundless

Due to the abrasive action of the ash it would seem almost prohibitive to install equipment of this kind and it was freely predicted that the company would be wrecked financially buying new equipment. By noting actual costs, however, it is evident that this is not true and that the system is economical. One pump shell and impeller will dispose of from 500 to 5500 t. of ash while the engine and side plates will last twice as long. The pipe line, by turning a quarter turn at proper intervals, was found to last three years. Turning the pipe does not require skilled labor and distributes the wear uniformly all around the entire diameter. Costs of pump parts and pipe line are given in the table together with a yearly summary of operation, unloading labor maintenances and power.

Cost of Pump Parts and Pipe Line

Pump shell	$ 200.00
Impeller	95.00
Suction side plates	70.00
Engine side plates	75.00
2000 ft. of 6-in. bell and spigot pipe	1550.85
40 flanged fittings	480.00
2 expansion joints	80.00
Cost of laying pipe	211.08
Total cost of pipe line	$2321.93

Cost of 1 Yr. Operation

Pipe line (1/3 total cost)	$ 777.31
Labor	6040.75
Pump costs	1258.95
Current	271.81
Total	$8348.82
Tons of ash disposed	19,621
Total tons of coal burned	100,344
Cost of ash disposal per ton	$ 0.425
Cost of ash disposal per ton of coal burned	0.0834

Originally the ash was dumped on a tract of about 2½ a., purchased by the electric company. This land, situated on the bank of the Rock River, had ample natural drainage to eliminate stagnant water pools, a condition which the health department of Rockford watch carefully. The question might arise as to the alternative when the available property is filled. The relay system of pumping, as used extensively in the transportation of oil, could be used to give access to other properties. Again the demand for cinders for construction purposes is increasing in most cities and the city of Rockford, finding the cinders of excellent quality for road building, is using a considerable part of the daily tonnage deposited so that there is little possibility of disposal becoming a serious problem in the future.

Factors Affecting Atomization in Oil Burners

DATA SECURED AND CONCLUSIONS DRAWN FROM EXPERIENCES WITH THE COMBUSTION OF OIL IN POWER PLANT FURNACES. BY J. F. BARKLEY*

IN THE course of the Government's fuel economy survey of its own power plants, studies and tests have been made of various oil-burning equipments under power plant boilers. There are now many types of burners being offered in the relatively limited field of power plant use. The majority of the types used may be grouped into two general classes,—those using steam to effect the atomizing of the oil, and those using mechanical means.

Burners using steam have had the most prominence in this field for a long period. The mechanical atomizing type of burner successfully applied on shipboard, however, pointed to a possible betterment in land work. The vision presented itself of a burner that would need no steam for atomizing, that would permit of air inlets or registers compactly arranged as a part of the entire burner, and that would require only the natural stack draft usually available in land boiler furnaces. Hence, rather recently there has been much development along this line, resulting in various types of burners.

TABLE I. REPRESENTATIVE ANALYSES OF PRODUCTS OF COMBUSTION OF FUEL OIL OBTAINED WITH VARIOUS BURNERS AND TYPES OF FURNACES

Type of Burner	Temperature of Oil, °F	Pressure of Oil, pounds per square inch	Dry products of combustion		
			CO_2 percent	O_2 percent	CO percent
Mechanical, natural draft					
Make "A"	230	121	11.6	5.4	0.1
	185	152	10.2	7.4	0.0
	242	101	10.1	7.4	0.0
"B"	285	195	10.3	6.4	0.0
	252	150	10.6	6.6	0.2
"C"	66	87	12.7	2.9	0.0
	326	248	12.2	4.2	0.1
	254	183	10.4	6.8	0.0
"D"	264	182	11.4	5.3	0.1
"E"	324	205	12.2	4.0	0.2
"F"	286	202	11.9	4.0	0.3
"G"	261	221	11.1	5.7	0.0
"H"	260	139	12.9	3.6	0.1
"I"	204	247	12.4	4.3	0.0
Steam atomizing					
Make "M"	142	46	13.3	2.8	0.0
"N"	194	43	14.1	2.2	Trace
	193	42	13.7	2.5	0.0

In Table I are grouped test items chosen from many tests showing representative analyses of the products of combustion obtained with various burners installed in various types of furnaces. In all these tests the burners were handled by experts and represent practically the best attainable for that particular arrangement. The boiler efficiencies ranged from 70 to 80 per cent. It will be noted that the burner using steam for atomizing were able to secure slightly better CO_2 and less O_2 without the presence of CO.

It is hardly proper to name such equipment as "oil burner." The mixing and burning is done in the furnace. It is quite important for it to have the proper shape and size to suit the particular burner used. The differences shown between the various mechanical burners would largely disappear if the correct furnace for each could be arranged. In the development of the mechanical burner much attention has been given to the devices for twisting the air and spraying the oil, but the important point is what happens after they get into the furnace. A cubic foot of oil at 60 deg. F. requires about 11,000 cu. ft. of air at 60 deg. F. for correct combustion. For combustion to progress, it is necessary for a continuous stream of air to pass each small oil volume as it is sprayed into the furnace. The products of combustion must move away from the surface of this oil volume. This means that the air must have a different velocity or direction than the oil. Since twisting movement of air and oil imparted at the burner entrance is soon lost, the importance of furnace shape and size is apparent.

In the combustion of an oil particle it is the carbon that is the more difficult to burn. It separates out as soot at the slightest provocation, and causes much heat loss. This may happen due to a chill as meeting with the boiler tubes, or a lack of air at the right moment. This may occur without the slightest indication in the usual flue gas analysis. To illustrate, the following data are taken from Bureau of Mines Bulletin 214, by H. Kreisinger and others. These samples were taken at a spot in a furnace just before the gases entered the tubes. They are quite representative, however, of completed combustion in some furnaces.

Per cent CO_2	Per cent O_2	Per cent CO	Soot (Grams per cu.ft.)	Soot (Per cent of carbon in oil)	Heat in Soot (Per cent heat in oil)
11.6	5.0	0.0	0.174	9.5	6.3
11.2	5.6	0.0	0.123	7.1	4.8
12.4	3.9	0.0	0.123	6.5	4.4
12.3	4.5	0.0	0.237	11.9	8.0
14.2	2.0	0.1	0.076	3.6	2.4
14.5	1.2	0.2	0.172	7.5	5.0

It will be noted that there is a great heat loss even when there is plenty of O_2 and no CO. In the next to the last sample CO had appeared, but there was less loss due to soot. In general, however, along with CO

*Fuel engineer, Bureau of Mines, Department of Commerce.

and low O_2, loss due to soot may be anticipated as shown by the last sample. In ordinary testing practice, the special equipment necessary to determine the soot loss is not always available. The soot loss appears in the heat balance as a high "unaccounted for" loss. The analysis of the products of combustion without the soot factor being taken into consideration, may lead to false conceptions, particularly in the correct design of furnaces.

For each furnace arrangement there is a certain percentage of CO_2 that gives the best results. The rule of adjusting burners to secure a slight haze of smoke at times may be quite wrong, as this smoke haze frequently can be secured with various percentages of CO_2 for the same furnace. Furnaces in which the carbon of the oil constantly tends to "drop out" as soot often give greater overall efficiencies with considerable excess air.

TABLE II. TYPICAL EXAMPLES OF STEAM REQUIRED BY TWO DIFFERENT CLASSES OF BURNERS

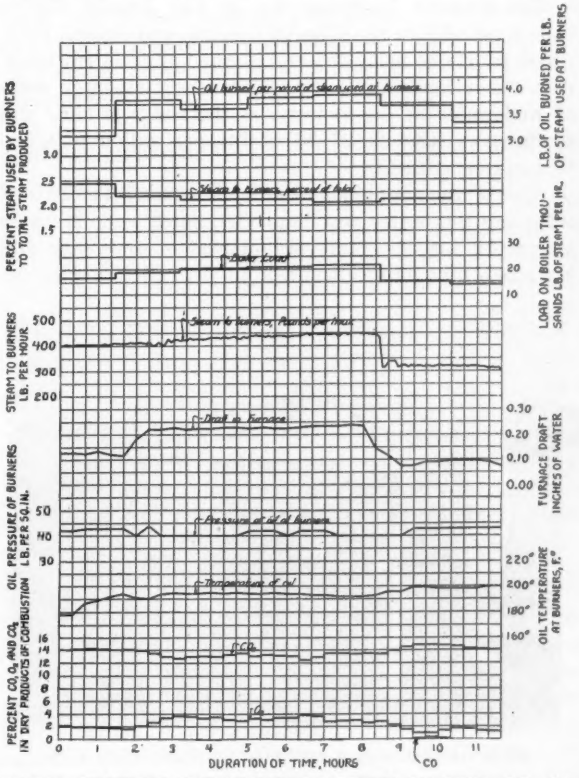
Type of Burner	Pounds of steam used for oil pump and heater per pound oil as fired	Pounds of steam used for burner per pound oil as fired	Total pounds of steam used per pound of oil	Per cent of B. Hp. (total steam developed) used for oil pump and heater	Per cent of B. Hp. (total steam developed) used for burner	Total per cent of B. Hp. (total steam developed) used	Per cent of total heat of fuel to heat in steam used for oil Pump and Heater	Per cent of total heat of fuel to heat in steam used for Burner	Per cent of total heat of fuel to heat in total steam used
Mechanical, natural draft	0.093	---	0.093	0.82	---	0.82	0.61	---	0.61
"	0.154	---	0.154	1.30	---	1.30	1.00	---	1.00
"	0.103	---	0.103	0.85	---	0.85	0.66	---	0.66
Steam atomizing	0.140	0.295	0.435	1.16	2.45	3.61	0.86	1.83	2.69
"	0.184	0.272	0.456	1.46	2.17	3.63	1.14	1.69	2.83

The exact way of establishing the correct CO_2 for a furnace is by a test where the water and oil are weighed.

In Table II are given some typical examples of the amount of steam required by the two different classes of burners for atomizing and for oil pump and heater. It might be expected that the mechanical type would require more steam for pumping and heating the oil, but in actual practice the amount of steam used is affected by so many factors, such as efficiencies of relatively small pumps and heaters, amount of oil circulated, etc., that this consistency seldom appears, as is borne out by the table. The steam used for atomizing shown in the table is an example of excellent practice, with expert firemen under test conditions. The accompanying curves show how this steam and other related factors vary over a period of time and at different boiler loads.

When these various burners are placed in the hands of the ordinary fireman for general operating purposes, the following has been observed: He finds that the mechanical natural draft burner is very sensitive and requires delicate adjustments to get the best results. Where several burners serve one furnace, each burner has its own peculiarities. Frequently the fireman will get a deposit of carbon in the furnace in the form of a mound two feet high. Later he may burn it up and not just understand how it all happened. The burner is affected appreciably by small changes in the draft, such as are caused by various wind velocities across the top of the stack. It requires constant attention to maintain any close setting. A damper on the boiler that can be moved extremely small amounts with accuracy, is needed. Careful damper adjustment gives better results than continued adjustment of secondary air registers.

When the steam atomizing burner is placed in the hands of the regular operating fireman, he seems to be able to operate it more closely to test conditions than he can the mechanical natural draft type. He uses very little more steam. In one instance, a plant engineer declared his steam burners must be using at least 10 per cent of all the steam he made. Whenever there were periods in which he had difficulty in carrying the load, he quickly arrived at the conclusion that the trouble was due to the amount of steam used by the burners. When the steam was measured it was found he was using about 3 per cent. With some types of


PERCENT STEAM USED BY BURNERS TO TOTAL STEAM PRODUCED
LB. OF OIL BURNED PER LB. OF STEAM USED AT BURNERS
LOAD ON BOILER THOUSANDS LB. OF STEAM PER HR.
STEAM TO BURNERS LB. PER HOUR
FURNACE DRAFT INCHES OF WATER
OIL PRESSURE AT BURNERS LB. PER SQ. IN.
OIL TEMPERATURE AT BURNERS, F.°
PERCENT CO, O2 AND CO IN DRY PRODUCTS OF COMBUSTION
Oil burned per pound of steam used at burners
Steam to burners, Pounds per hour
Draft in furnace
Pressure at oil at burners
Temperature of oil
CO2
CO
DURATION OF TIME, HOURS

CURVES SHOWING VARIATIONS IN ITEMS OF TEST OF OIL BURNER USING STEAM FOR ATOMIZATION

burners this will rise to as high as 5 per cent. Regular operating conditions of 13 per cent CO_2 are not unusual, for the better class of burner and furnace arrangements.

In making a comparison of the two types discussed, as far as efficiency only is concerned, the following might be considered. The mechanical natural draft type has the advantage of the steam type by, say 2 to 3 per cent of the total heat in the fuel chargeable to the latter's steam for atomizing. In order to compensate for this handicap, the steam type must be able to obtain better combustion, so that the loss in the dry flue gases is less than that obtained with the mechanical type. For example, a CO_2 content of 9.6 per cent gives about 3 per cent more loss in the dry flue gases than 13 per cent CO_2. Much effort and study have been put upon the furnace in the use and development of the steam type. The solution of the problem in the development of the mechanical natural draft type, which is at a disadvantage when compared to the forced draft type, is in furnace study rather than concentration on burner arrangements.

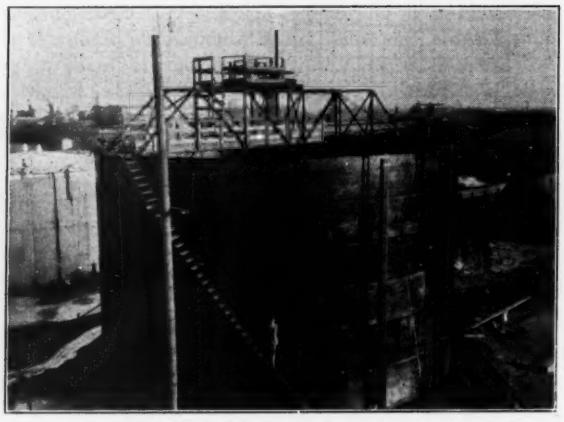
High-Pressure Filtration of Softened Water

HIGH HEAD, FINE CLEAN SAND BED OF LOW UNIFORMITY AND HIGH POROSITY AND REMOVAL OF DEPOSITED SOLIDS GIVES CLEAR FILTERED WATER. BY L. H. BIGGAR*

DURING the past year experimental and large scale test work has been carried out in the field of filtration of softened water. The results have been so successful, and some of them unexpectedly so, that an outline of the problems met and solved should be of interest to all large steam users.

The General Petroleum Co. in Los Angeles, Calif., had much difficulty with its boilers and steam lines, which had to be inspected and cleaned at frequent intervals. This condition is true with nearly all large users of well water in the vicinity, as the water is hard and contains an average of 20 grains per gallon of scale-forming constituents.

One of the simplest and most economical methods of softening this water was employed, namely the addition of proper amounts and proportions of soda ash and hydrated lime but difficulties in operation continued.



GENERAL PETROLEUM CO., LOS ANGELES, USES HIGH-PRESSURE SAND FILTRATION SUCCESSFULLY

It was found that, even with a long period of sedimentation after aeration and mixing, a very fine slow-settling turbidity remained suspended in the decanted water, which caused a deposit to start easily in the boilers and accelerated further scaling. As this could be remedied by only one or two methods, the merits and costs of each were investigated and a decision was made to test, thoroughly, the possibilities of sand filtration.

In principle, there was nothing new in this procedure but the methods and mechanical means employed were radically new. The high-pressure rapid sand filter had already been employed and discarded because it gave a turbid filtrate, under the excessive rates of flow required by plant expansion. Also, it was found that a large quantity of filtered water was being wasted as extra back-wash to remove the lime mud which gradually saturated the filter medium.

The first discovery of interest was the reason for the lack of success of gravity apparatus in sand filtration of certain industrial water supplies. This failure was due to the precipitate penetrating the sand. After a partial investigation of the literature on the subject, it was found that all the conclusions and data on this work were confined within certain limits of water pressure or head used. It was also found by experiment that satisfactory results could be obtained on water similarly treated, using a fairly high head and a filter bed composed of very fine uniform sand. Good rates of flow and filtrates of perfect clarity were obtained with no penetration of the fine particles into the filter bed. Several authorities were consulted, who outlined the precedents established in these industrial water supply tests and were of the opinion that satisfactory results could not be obtained but all their test work was conducted using low-head, gravity sand filters for the removal of precipitates from softened water and penetration often resulted. Naturally, the few successful results obtained using higher heads were discounted.

To determine the reason for the apparent success of these few tests and to confirm an hypothesis formulated from them, a number of other tests were then made. The hypothesis—later proven correct by large scale practice—was that the water to be filtered must be under slightly more pressure at the surface of the filter medium than where the air was introduced in the reaction tanks. The slow sand filter, low-head, softened water experiments were carried on under approximately 4 to 10 ft. of head, whereas it was found vital in this case to use *at least* 13 ft. of head. The water softening process is carried on in a large tank 10 ft. deep.

A mixture of soda ash and lime, dissolved in a small amount of water, is introduced into this tank, the whole body being thoroughly mixed by means of air introduced through a circular perforated pipe near the tank bottom. After a definite aeration and agitation period, the mixture is allowed to settle and probably 80 to 90 per cent of the solids are settled out, depending on the length of this settling period. The surface liquid is then decanted by means of a "swing pipe" attached to the suction of a centrifugal pump.

To prove the hypothesis, tests were carried out on a small sand filter, with 3 ft. of beach sand as a medium and with water heads varying from 33 to 4 ft. On all tests it was found that penetration of the sand occurred when the head was less than 13 ft. but, with heads greater than that, perfect filming took place on the sand surface, even at the highest rates of flow obtainable under the heads used, and the clarity of filtrate was excellent. Under 12 ft. or less of head, there was a definite volcanic action in the sand, visible in glass models. It was then concluded that, owing to the pressure drop, some air in the water escaped upwards and formed craters in the sand surface, into which the precipitate gradually worked.

Although this hypothesis has been proved correct, the reasons have not been thoroughly analyzed as yet. Our ideas are that, under aeration, the water becomes saturated with air, the amount being dependent upon temperature and pressure. In addition, a large amount of finely divided air is diffused through the liquid and

*The Hardinge Co., Inc., York, Pa.

carried off in it in a suspended state when the water is decanted. The water then goes to the filter and, if the pressure drop, as it passes through the first inch or so of sand, is sufficient to lower the pressure at that point below the pressure required to put the air into solution, it automatically breaks loose in the form of bubbles which rise to the surface. The same effect might also be produced by the sand breaking down the "filming" condition of the "suspended" air. We have considered it possible that the "suspended" air is partially kept in that state by combination with the finely divided solid matter and thus may act as it is known to do with oil emulsions. Should this be so, the air does not break loose, except in the filtrate, if the head on the sand surface is sufficiently great, and this leads us to believe that it may be a combination of the two actions.

Having definitely proved the feasibility of the procedure, the company installed a new type of sand filter known as the Hardinge Clarifier. This machine employs either vacuum or water head and has been successfully used in metallurgical practice in the clarification of solutions in that field but had never been used in a problem of this nature. It consists of a tank of relatively large diameter and depth (in this case 54 ft. diam. by 31 ft. depth) in which is built a false bottom to support the filtering medium. The filtrate runs off from a common point below the filter base and is either pumped or conveyed to its points of use.

In all cases of this nature, the filtering medium should consist of very fine clean sand with a low coefficient of uniformity, giving a high porosity and good clarification. This sand is placed on top of the filter base, or false bottom, and may be anywhere from a few inches to several feet in depth. Spanning the tank is a steel truss, supporting a central vertical shaft which, in turn, supports and rotates at intervals a spiral-shaped blade. This spiral is of such shape that it moves the solids deposited on the sand, radially, to a central well yet requires little power. The mechanism is so arranged that the spiral may be automatically lowered any desired distance when it is found necessary to remove a minute stratum of the sand surface as well as the mud on the bed.

Water head in the tank gives the necessary pressure to effect the rapid filtration of the turbid decanted liquor from the reaction tanks, by forcing it through the sand at a relatively high rate. This head must be maintained in excess of 13 ft. at this plant and, with that as a guide, perfect filming of lime mud has always taken place on the sand surface, no penetration having occurred.

The second discovery was the most unexpected. This was the filtering quality of the precipitate. Originally, it had been intended to rotate the spiral once a day and lower it 1/100 part of an inch into the sand to remove that much of the sand surface with the coating of lime. But, much to our surprise, after several months operation at rates of flow varying from 800,000 to 1,500,000 gal. per 24 hr., the sand cut has been exceedingly small, not over ½ in. to date. At this rate, the sand bed should last 20 yr.

Filtrate has been of excellent clarity and the economic results have already exceeded expectations. The tank contains storage for 9-hr. supply of treated water, in case of power shut-downs (which would shut down the electrically operated well pumps). Services of only one man are required to watch a small motor run for half an hour daily. Filtrate is pumped to the power house continuously and the mud is drawn out periodically by opening a valve on the line, which drains the central well in the sand.

Previously, boilers had to be cleaned every 60 or 70 days but, after a period of 60 days, operating with this filtered water, practically no scale was noted.

Perhaps both the discoveries which form the basis of this article should not be called "discoveries." They have been termed such in good faith, however, and it is sincerely hoped that what helped to solve this problem may assist others where problems of like nature are encountered.

Experiments with Voltage Harmonics

Discussing the results of experiments and investigations as to the influence of voltage harmonics on the correction of power factor by means of condensers, Edward Hughes reaches the conclusion as given in Engineering of London, that the power factor of a system having harmonics in the voltage wave cannot be increased to unity by means of condensers. With sinusoidal waves, the maximum rate of change of power factor with change of capacity of the phase-changing apparatus occurs at a power factor of 0.82, regardless of the power factor of the system. With non-sinusoidal waves, the lower the initial power factor, the lower is the power factor at which the rate of improvement is greatest. Also, the greater the magnitude and the higher the frequency of the harmonic in the voltage wave, the lower is the power factor at which this maximum rate of improvement occurs.

Mr. Hughes states that it is quite possible that after calculating the capacity needed to give unity power factor for sinusoidal waves, the final power factor, after installing the condenser, may be found lower than the initial value. When a consumer is charged on kv.a. of maximum demand as indicated on a demand meter, the presence of harmonics in the condenser current penalizes him, especially if the demand meter is of induction type. His most economical power factor, under these circumstances, will be less than that based on sinusoidal wave form. If the power factor determining the charge to the consumer is taken from a power factor meter, or from the ratio of meter readings, the consumer may obtain practically full benefit from the installation of condensers and, for practical purposes, his most economical power factor is the same as that based on sinusoidal wave form.

Speaking of the successful growth of the country-wide safety movement, R. W. Campbell, first president of the National Safety Council, says that not only is it true that our annual accidental fatalities far exceed the total of American lives lost in the world war, it is also true that the saving of life during the past sixteen years —the difference between actual deaths during that period and what the total would have been at the 1907 rate— is about five times our loss of life in the recent war. Every two years—despite the automobile—we save enough lives, as compared with the 1907 rate, to replace our sacrifices in France.

New Methods of Coal and Coke Analysis

American Society of Testing Materials Proposes Revision of Standards

THERE APPEARS to be some confusion on the part of some coal chemists as to the interpretation of the permissible differences in duplicate determinations, according to the Committee on Coal and Coke of the American Society of Testing Materials, which presented a report at the annual meeting held at Atlantic City June 21 to 25. The committee believes that these permissible differences should be more clearly stated, also that it is desirable to print all the tolerances under a special section at the end of the Standard Methods of Laboratory Sampling and Analysis of Coal instead of printing permissible differences after each method of test, as is now done. The proposed changes do not change the permissible differences now given but do state them more clearly; also new permissible differences are given in the case of determinations of carbon, hydrogen and nitrogen. It is recommended that the following revision in the standard methods be accepted for publication as tentative:

On pages 987, 990, 993, 1000 and 1012 of the 1924 Book of A. S. T. M. Standards omit the permissible differences in duplicate determinations as given and in place thereof add the following section at the end of the standard methods:

Tolerances

The permissible differences between two or more determinations shall not exceed the values as specified.

A. On laboratory samples, crushed to pass through a No. 20 sieve.

	Permissible Differences Same Laboratory	Different Laboratories
Moisture:		
Under 5 per cent	0.2	0.3
Over 5 per cent	0.3	0.5

B. On laboratory samples, crushed to pass through a No. 60 sieve.

	Permissible Differences Same Laboratory	Different Laboratories
1. Moisture:		
Under 5 per cent	0.2	0.3
Over 5 per cent	0.3	0.5
2. Ash:		
No carbonates present	0.2	0.3
Carbonates present	0.3	0.5
Coals with more than 12 per cent of ash containing carbonate and pyrite	0.5	1.0
3. Volatile Matter:		
Bituminous coals	0.5	1.0
Lignites	1.0	2.0
4. Sulphur:		
Under 2 per cent	0.05	0.10
Over 2 per cent	0.10	0.20
5. Ultimate Analysis:		
Carbon	0.3	..
Hydrogen	0.07	..
Nitrogen	0.05	..
6. Calorimetric Determination:		
Permissible differences in per cent	0.3	0.5
7. Fusibility of Coal Ash:		
Permissible differences in deg. Cent.	30	50

Revision of Tentative Method of Test for Fineness of Powdered Coal

The committee has received criticisms regarding the sieves specified in this method. These criticisms are that sieves with larger openings than those specified should be included in the series, also that some of the sieves now specified could be omitted. It has also been suggested that specifications for the sieves should be given. The committee believes that these criticisms are well founded and that the tentative method be revised accordingly. It is recommended that the following revision be made in the tentative method:

WHEN TESTING FINENESS OF POWDERED COAL, THIS TABLE SHOWS THE REQUIREMENTS FOR SIEVE OPENINGS AND WIRE DIAMETERS WITH PERMISSIBLE VARIATIONS

Designation		Sieve Opening		Wire Diameter		Tolerance in Average Opening, per cent	Tolerance on Wire Diameter, per cent		Tolerance in Maximum Opening, per cent
U. S. Standard Sieve Series Number	Micron Designation	mm.	in.	mm.	in.		Under	Over	
16	1190	1.19	0.0469	0.84	0.0213	±3	15	30	10
30	590	0.59	0.0232	0.33	0.0130	±5	15	30	25
50	297	0.297	0.0117	0.188	0.0074	±6	15	35	40
100	149	0.149	0.0059	0.102	0.0040	±6	15	35	40
200	74	0.074	0.0029	0.053	0.0021	±8	15	35	60

Section 1.—Change from its present form: namely,

"Sieves Nos. 40, 50, 70, 100, 140, and 200 of the United States Standard Sieve Series, with close-fitting pans and covers, shall be used."

to read as follows:

"Sieves Nos. 16, 30, 50, 100, and 200 of the U. S. Standard Sieve Series, each with a close-fitting pan and cover, shall be used. Wire cloth for the sieves shall be woven (not twilled) from brass, bronze, or other suitable wire and mounted on the frames without distortion. To prevent the material being sieved from catching in the joint between the cloth and the frame, the joint shall be smoothly filled with solder, or so made that the material will not catch. The sieve frames shall be circular, about 20 cm. (8 in.) in diameter and about 5 cm. (2 in.) or 2.5 cm. (1 in.) between the top of the frame and the cloth. The sieve openings and wire diameters shall conform to the requirements as given in the accompanying table.

Experience has shown that the "Rapid Routine Method by Machine Sieving" can be simplified by changing somewhat the method of cleaning the sieves and weighing the residues remaining on the sieves. The committee, therefore, recommends that the second paragraph under "Rapid Routine Method of Machine Sieving" be changed to read as follows:

"The same sieves should be used as specified, for hand sieving, and each sieve should be provided with a

close-fitting pan and cover to prevent possible loss of material during sieving. A 50-gram sample of air-dried coal should be placed on each sieve (previously tared), and the sieves shaken until not more than about 0.1 gram passes through the finest sieve of the series in the machine in one minute of continuous sieving. The sieves should then be removed from the machine and the under surface of each sieve brushed clean. Sieving should then be resumed until not more than 0.1 gram passes through the finest sieve of the series in the machine in one minute of continuous sieving, when the test shall be considered finished, after which the sieves should be cleaned as before and weighed on a balance sensitive to 0.1 gram. The fineness should be calculated and reported as in the hand-sieving method."

TENTATIVE SIEVE TESTING METHOD FOR ANTHRACITE

Scope.—This method of testing applies to sieve tests on anthracite to determine the oversize or undersize in any given size. The size of gross sample is at variance with the A. S. T. M. Standard Method of Sampling Coal (D 21—16) due to the fact that the sample cannot be broken up as outlined in the standard method.

The method here outlined corresponds more nearly with present practice of routine testing in the anthracite field.

Apparatus.—The screens employed in the size testing of anthracite coal are the following:

Name of Size			
Egg—			
	Passing 3 7/16-in. screen	Retained on	2 8/16-in. screen
Stove—			
	Passing 2 8/16-in. screen	Retained on	1 9/16-in. screen
Chestnut—			
	Passing 1 9/16-in. screen	Retained on	11/16-in. screen
Pea—			
	Passing 11/16-in. screen	Retained on	8/16-in. screen
Buckwheat—			
	Passing 8/16-in. screen	Retained on	5/16-in. screen
Rice—			
	Passing 5/16-in. screen	Retained on	3/16-in. screen
Barley—			
	Passing 3/16-in. screen	Retained on	3/32-in. screen

Procedure—Egg, stove and chestnut sizes shall be screened in box screens, 2 ft. by 2 ft. by 4 in., in increments of 5 lb., the screen to be shaken with a reciprocating horizontal motion at an approximate rate of 100 strokes per minute for a specified period of time.

Pea, buckwheat, rice and barley sizes shall be screened in 8-in. circular screens in some approved mechanical shaker in increments of approximately two pounds for a specified period of time. In the case of hand screening, the test may be considered complete when the undersize passing through the screen in one minute is the same in weight for two successive minutes.

Sampling (From railroad car). The gross sample shall be about 100 lb. taken from at least six places in the car about one foot below the surface.

The size of the test samples shall be as follows:

Egg, Stove and Chestnut size, 25 lb.

Pea, Buckwheat, Rice and Barley size, 5 lb.

Proximate Analysis—In the case of coal and coke, determination by prescribed methods of moisture, volatile matter, fixed carbon (by difference) and ash, unless otherwise specified, the term "proximate analysis" does not include determinations of sulphur or phosphorus or any determinations other than those named.

Ultimate Analysis—In the case of coal and coke, the determination of the carbon and hydrogen in the material, as found in the gaseous products of its complete combustion, the determination of sulphur, nitrogen and ash in the material as a whole, and the estimation of oxygen by difference.

Determination of phosphorus is not by definition a part of ultimate analysis of coal or coke but may be specified when desired.

When the analysis is made on an undried sample, part of the hydrogen and oxygen as determined is present in the incidental or free moisture accompanying the coal. Therefore, in comparing coals on the basis of their ultimate analysis, it is advisable always to state the analysis on both the "as received" and dry basis

Moisture—Essentially water, quantitatively determined in a material by definite prescribed methods which may vary according to the nature of the material. It should be noted, however, that such methods may not determine all of the water present.

Ash—Inorganic residue remaining after ignition of combustible substances, determined by definite prescribed methods.

Note 1—The ash as thus defined may not be identical in composition or quantity with the inorganic substances present in the material before ignition.

Volatile Matter—Those products, exclusive of moisture, given off by a material as gas or vapor, as determined by definite prescribed methods, which may vary according to the nature of the material.

Fixed Carbon—In the case of coal, coke and bituminous materials, the solid residue other than ash, obtained by destructive distillation, as determined by definite prescribed methods. It is made up principally of carbon, but may contain appreciable quantities of sulphur, hydrogen, nitrogen and oxygen.

Coke—The infusible, cellular, coherent solid material obtained from coal as the residue from the destructive distillation. Such material obtained from the destructive distillation of petroleum or petroleum residues is known as "petroleum coke," and that obtained from the destructive distillation of coal-tar pitch is known as "pitch coke."

Beehive Coke—Coke manufactured in beehive, rectangular, or similar forms of ovens in a horizontal bed, where heat for the coking process is secured by combustion within the oven chamber.

By-product Coke—Coke manufactured with attendant recovery of by-products, in ovens that are heated externally and having properties making it available for metallurgical purposes.

Coke Breeze—The fine screenings from crushed coke or from coke as taken from the ovens, of a size varied in local practice but usually passing a ½-in. or ¾-in. screen opening.

Dry Coke—Coke which has been dried to constant weight at temperatures not less than 104 deg. C., not more than 200 deg. C. in the case of lump coke, and between 104 and 110 deg. C. in the coke passing a No. 60 sieve, in accordance with regulation methods of determining moisture.

Reducing Turbines in Paper Mills

LARGE SAVINGS IN POWER COST OVER USE OF CONDENSING TURBINES AND LIVE STEAM FOR PROCESS WORK. BY F. A. WESTBROOK*

EFFORT to eliminate waste in industry which is now being made on such a large scale and which is receiving the support and encouragement of Secretary Hoover finds a productive field of endeavor in those operations requiring process steam.

Many of the industries which use steam in their manufacturing operations need it in large quantities, which they find it necessary to generate at high pressures and then reduce by some means or other to low pressures suitable for their needs. Formerly this reliable in operation, take up little floor space and run satisfactorily at the highest back pressures used in most industrial processes, their range of application is wide.

Paper mills are good instances. In one large and progressive establishment of this kind, it has been possible to secure electrical power in this way for $18.10 per kw-year where the year consists of 310 days of 24 hr. each. This includes all charges such as maintenance, repairs, depreciation, interest, insurance, taxes, etc., the life being assumed as 15 yr.

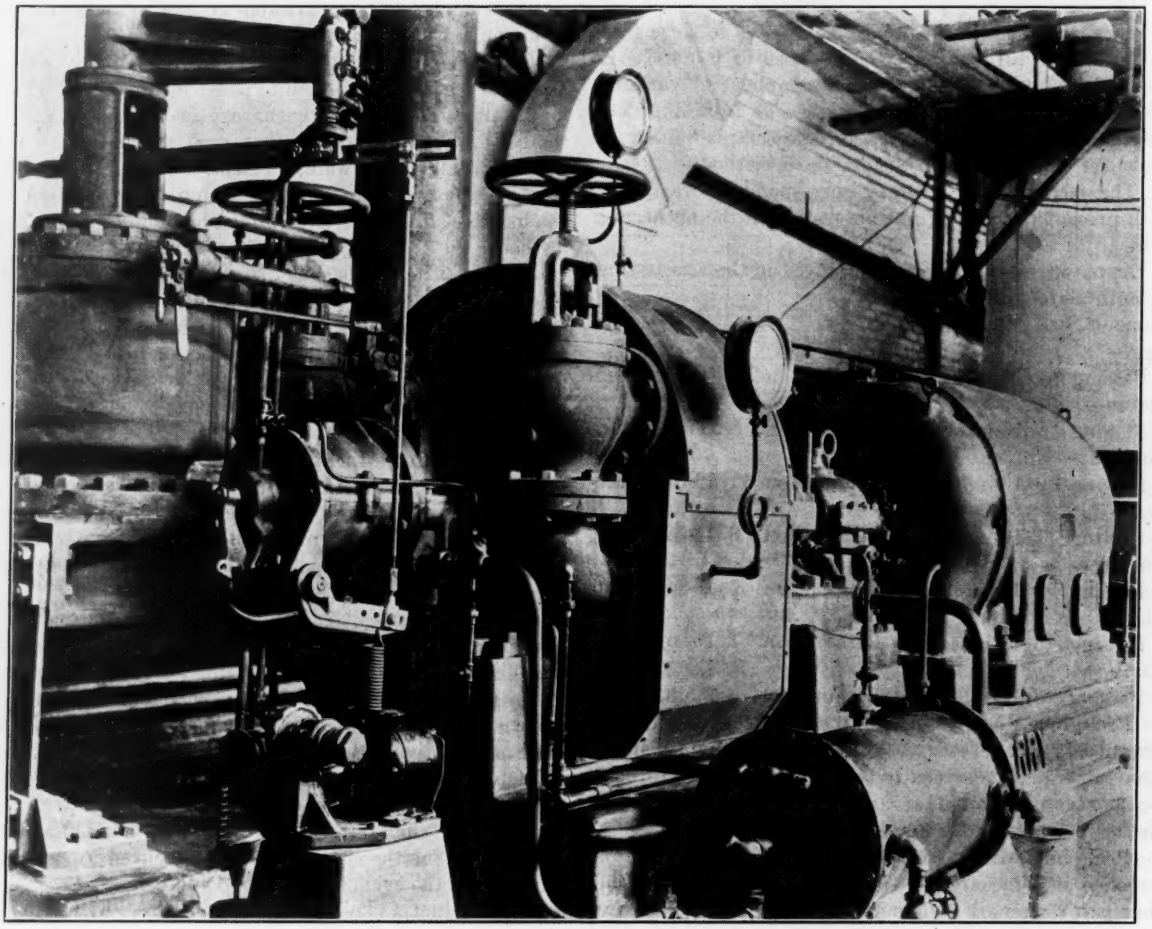


FIG. 1. THIS TURBINE-GENERATOR SET IS SAVING ITS COST IN A YEAR AND A HALF

duction in pressure was largely accomplished by means of reducing valves and, even now, this method is used to a considerable extent. But the wastefulness of doing this is so glaringly apparent that industrial executives have been quick to take measures to utilize this otherwise wasted energy.

One of the simplest and best ways of doing this is to use a steam turbine, connected to an electrical generator, as a reducing valve. As good turbines are reliable in operation, take up little floor space and run satisfactorily at the highest back pressures used in most industrial processes, their range of application is wide.

In this plant steam is generated in the boilers at 180 lb., 50 deg. superheat and is used in process work at 110 lb., 210,000 lb. of steam per hour at that pressure being required.

Two 625-kw. Terry reducing turbines to operate at 110 lb. back pressure have been installed. The high-pressure steam is expanded down to the pressure of utilization through these, each unit being designed to pass 105,000 lb. of steam an hour. They are equipped with automatic back-pressure controls and governors.

*Consulting engineer, Canaan, Conn.

The average daily output of the two units is 900 kw., although, if more electrical power is required, the boiler pressure can be run up to 190 lb., when each machine will deliver 700 kw. without giving an excess of steam above that required for process work.

The low cost of $18.10 per kw-year, including annual charges on the turbine-generator equipment based on a 15-yr. life, is due to the fact that little extra coal has to be burned under the boilers to secure the electrical power because most of the energy for driving the turbines is secured by expanding the large quantity of steam from 180 lb. down to 110 lb., which would otherwise be wasted.

OPERATING FIGURES FOR 4 MO.

Month	No. 1 Unit kw-hr.	Days in Operation	No. 2 Unit kw-hr.	Days in Operation	Total kw-hr.
January	232,800	21	54,800	5	287,600
February	252,000	25	252,200	25	504,200
March	273,600	26	282,000	27	555,600
April	180,000	24	213,720	24	453,720
Total for 4 mo.....					1,801,120

As the load requirements are somewhat less during the summer months than for those shown above, it is

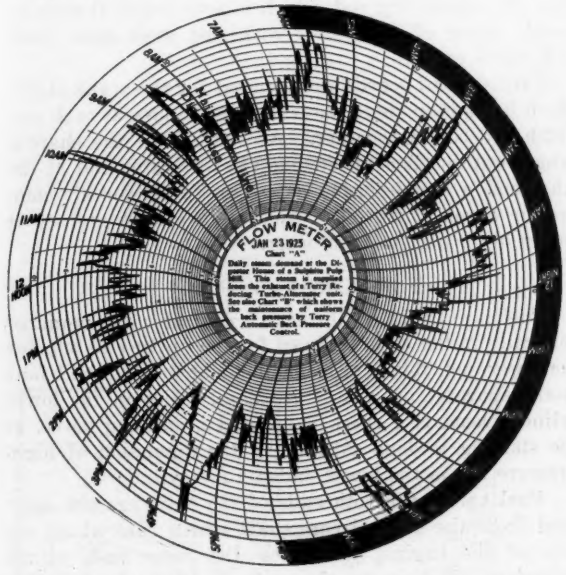


FIG. 2. STEAM DEMAND AT THE DIGESTER HOUSE VARIES WIDELY AND RAPIDLY

safe to say that the total output for the two turbine-generator units will amount to about 5,000,000 kw-hr. per yr.

It should be understood that this is not all the power used in the plant; it is simply a part of the supply procured at an exceptionally small cost. There are, in fact, several large electrical generating units run by condensing steam turbines and it is the difference in the cost of the power from these two systems which is most startling.

Cost of power from the large condensing steam units is $75 per kw-year or $56.90 per kw-year more than for that generated by the reducing turbines. In other words, the power secured from the latter source represents a saving of something like $38,000 a year; that is, it would have cost that amount more, if condensing steam units had been added sufficient to produce the same amount of electrical power.

The total cost of the reducing turbo-generator installation, including all plant charges, piping, foundations, etc., was approximately $60,000, which means that the return on the investment is 63.4 per cent a year and that it will pay for itself in 1.58 yr. Based on the assumption that the life of this equipment will be 15 yr., the total saving will be $570,000.

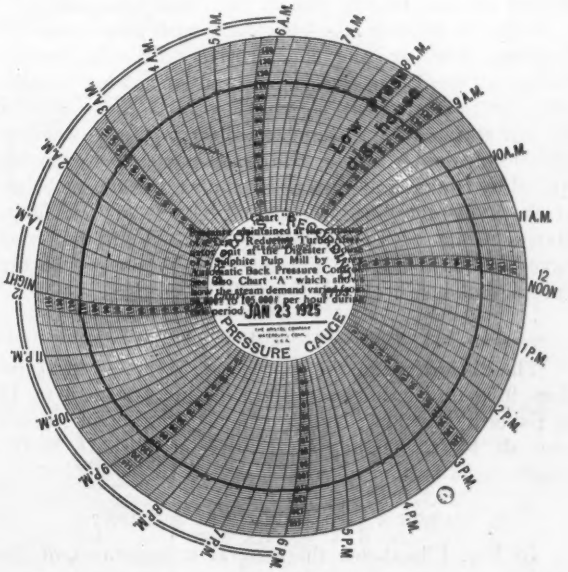


FIG. 3. EXHAUST PRESSURE ON THE TURBINE REMAINS PRACTICALLY CONSTANT

This plant also has water power and the condensing steam units are used mostly to supply deficiencies in the hydro-electric output. This happens frequently, both because of heavy power requirements and because of unfavorable water conditions at certain seasons. The two turbo-generator units are kept running all the time and care for most of this deficiency. They render it unnecessary to start up the large condensing units except on comparatively rare occasions.

It is by embracing all such possible opportunities to effect economies that waste in industry will be reduced eventually to a minimum. The sum actually secured may not seem relatively very much in a large plant, but $38,000 a year represents a normal interest rate on a substantial investment. Probably no well managed organization would hesitate to make such a saving, as soon as it sees the possibility.

Accompanying charts show the daily steam demand at the digester house, which is supplied from the exhaust of the turbines, and the pressure at the exhaust of the turbines through which the boiler pressure is reduced.

SIGNS ON New York's Great White Way, Broadway theater district, aggregate 25,000,000 c.p. and use nightly 17,800 kw-hr. One 4-story structure, only 8 ft. deep, which was built solely to carry display signs, brings annual rental of $90,000.

This Diesel Engine Develops 15,000 Hp.

THE NINE CYLINDERS ARE DOUBLE-ACTING ON A TWO-STROKE CYCLE WITH SCAVENGING AIR FURNISHED BY AN AUXILIARY UNIT

INCREASE in the size of Diesel engines has been rapid during the past few years, especially since they came into use for Marine propulsion. In England, the Diesel Engine has become nearly standard practice for smaller power stations because it is a self-contained machine of high efficiency using a fuel which is easily handled, standby losses are small and the engine can be started up and quickly put on the line at any time.

Little or nothing has been done with large units in England, however, and comparatively little in United States, although the sizes have been increasing considably, but an application has now been made in the Nauhof station of the Hamburg Electric Works where a 15,000-hp., double-acting, two-cycle engine has been installed by Blohm and Voss of Hamburg, the engine being of the type developed by the M. A. N. of Germany. Marine units of three-cylinder and six-cylinder type have been built but the present set is the largest so far known that has been constructed.

PRINCIPAL DIMENSIONS

The dimensions of the engine are: Number of cylinders, 9; cylinder diameter, 2 ft. 9⅞ in.; stroke, 4 ft. 11 in.; speed, 94 r.p.m.; length over all, 76 ft. 9 in.; width over all, 14 ft.; height from center line of shaft, 23 ft.; height from bottom of crank case, 38 ft. 9 in.

STATION PLANNED FOR ENLARGEMENT

In Fig. 1 is shown the general arrangement of the station, the present installation including two electrically-driven compressor units for furnishing scavenging air, arranged across the end of the station, a series of fuel tanks in a separate building at one side of the station, the present main unit and space on the other side of the engine hall for another unit of the same size. The generator, which is for 13,000 kv.a. at a power factor of 0.8 and generating at 6000 volts and 50 cycles per second, is direct connected to the end of the engine shaft, while on the other end of the shaft is a two-cylinder, three-stage air compressor to provide starting and injection air. As stated before, the scavenging air is furnished by independent electrically-driven compressors.

CONSTRUCTION DETAILS SHOW CAREFUL DESIGN

Constructional features of the engine are shown in Fig. 2, cast iron being used for the base plate and intermediate frames. Since the engine is double acting, there are very large tension strains as well as compression and, in order to avoid making the frame members as heavy as would be required to carry the tension, bolts are run from the upper cylinder end down to the bottom of the crank case, the nuts of these bolts showing at the top and bottom of Fig. 2. Liners are provided inside the cylinder extending inward from each end, expansion being taken care of from the fixed ends inward and a smooth liner surface for the passage of piston rings being provided by alternate projections and spaces on the inside ends of the liners, which dovetail together.

Cylinder heads are held in place by multiple bayonet joints as indicated in Figs. 2 and 3, the joints between the heads and the cylinders being made by the insertion of copper rings.

Scavenging air enters the cylinder near the center, passes across to the opposite side and out to the head, then back to an exhaust port in the center, thus sweeping out all burned gases. This natural action of the incoming air is facilitated by making the top and the bottom sections of the piston concave, which sets up a swirling motion that sends the scavenging air clear to the ends of the cylinder.

Cooling water is introduced into the lower cylinder head then carried by pipes and ports to the jackets surrounding the liners, thence to the top cylinder head. Cooling of the pistons, as they are hollow and built up of end sections separated by a central portion, is accomplished by supplying water through the hollow piston rods, by vent pipes near the cross-head, which are connected to telescoping tubes. Each end of the piston carries seven rings in order to prevent leakage under the high pressures of compression and combustion.

The guide for the end of the piston rod is of slipper type, the connecting rod, which is four crank throws in length, being of mild steel with cast steel ends lined with white metal.

Forged open hearth steel is used for the crank shaft, which is made in three parts, having flanges at each end which are bolted together. At one end of the shaft a flange coupling is connected to the generator and at the other end a double crank extension forms the air compressor crank shaft. The nine main cranks are set at angles of 40 deg. to each other.

FUEL VALVES AND PUMPS

Fuel is introduced through a central valve mounted vertically in the cylinder head for the upper end but, for the lower end, this arrangement is not possible and four small separate fuel valves are used. Also in the lower cylinder head is a check valve and a starting valve, as the starting is done entirely by the admission of high-pressure air to the lower ends of the cylinders.

Fuel valves for both ends of the cylinders are operated from the general cam shaft which runs along one side of the engine, just below the lower ends of the cylinders. Rollers on the ends of levers take motion from the various cams and this is transmitted by rods to a suitable point on the bell-crank levers which operate the fuel valves. The valves are closed by heavy springs when released from the action of the cams. Fuel oil pumps, of which there is one for each cylinder, are also operated from the cam shaft, each pump having two plungers, one to deliver oil to each end of its cylinder.

Three platforms are provided; the one at the top is to give access to cylinder heads and to the top fuel valves; the one at the middle giving access to the cam shaft and its operative mechanism and the lower inlet valves, also for control of the piston-cooling devices and the water outflows of all jackets. The lowest platform is for access to the crank shaft and connecting rods. Control of the engine is from a platform at the compressor end on the same level as the middle platform

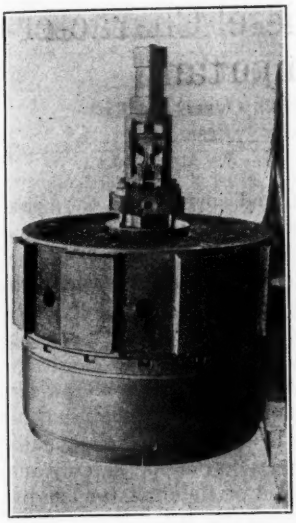


FIG. 3. CYLINDER COVERS ARE HELD BY BAYONET JOINTS

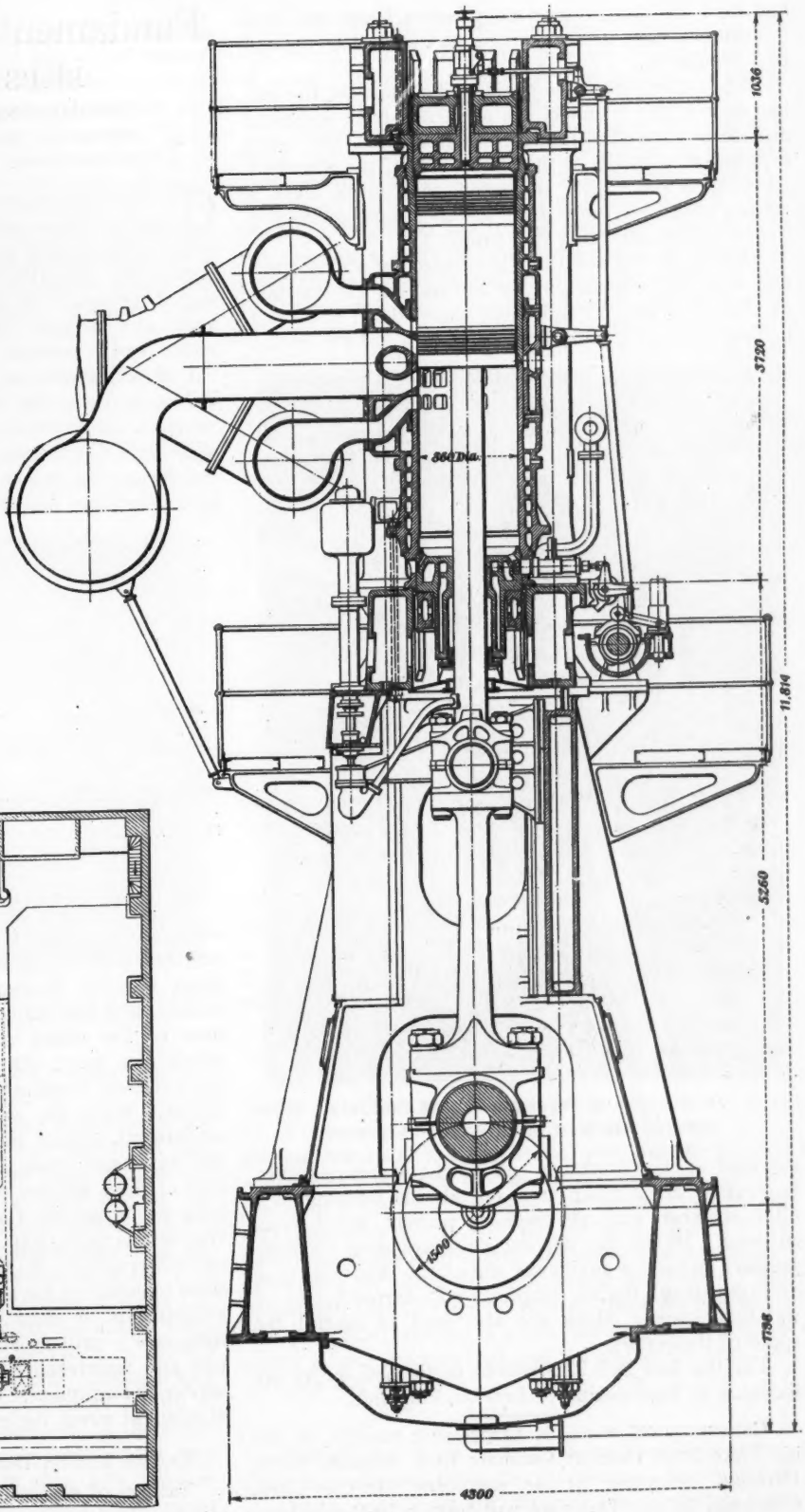


FIG. 2. CAST-IRON CYLINDER LINERS, SEPARATE CAST-IRON HEADS, SLIPPER CROSSHEAD GUIDE, CENTER SCAVENGING PORTS AND STEEL THROUGH BOLTS FROM HEAD TO BOTTOM OF THE CRANK CASE ARE NOTABLE FEATURES

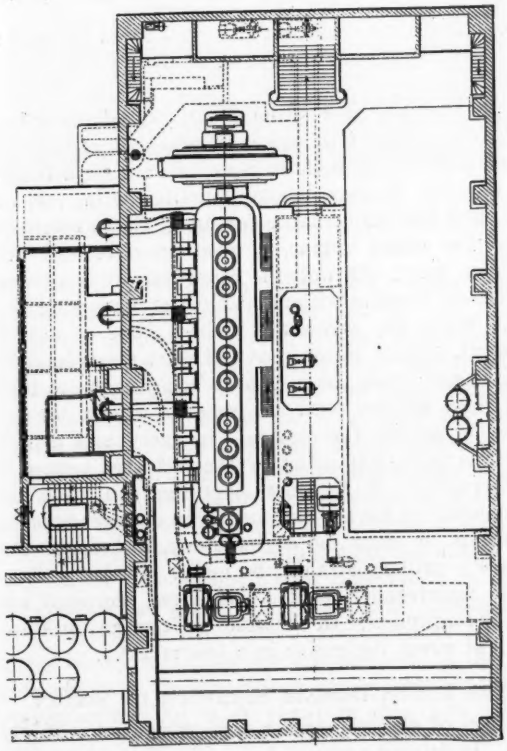


FIG. 1. NAUHOF STATION AT HAMBURG IS PLANNED FOR THE PRESENT UNIT AND A FUTURE ONE OF LIKE SIZE

and here are concentrated all pressure gages and feed indicators as well as the starting and control levers and fuel regulators.

When starting up the engine, oil pumps for the bottom ends of the cylinders are prevented from operating and air is introduced into these bottom ends, fuel being supplied at all times to the upper ends of the cylinders. As soon as the engine is started, the control lever is thrown over, thus cutting off the air supply to the bottom ends and admitting fuel supply.

Cooling of the generator is effected by a closed system with fan circulation, hot air leaving the machine at about 125 deg. F. and being cooled down to 80 deg. before its return. Excitation is from a 151-kw. exciter

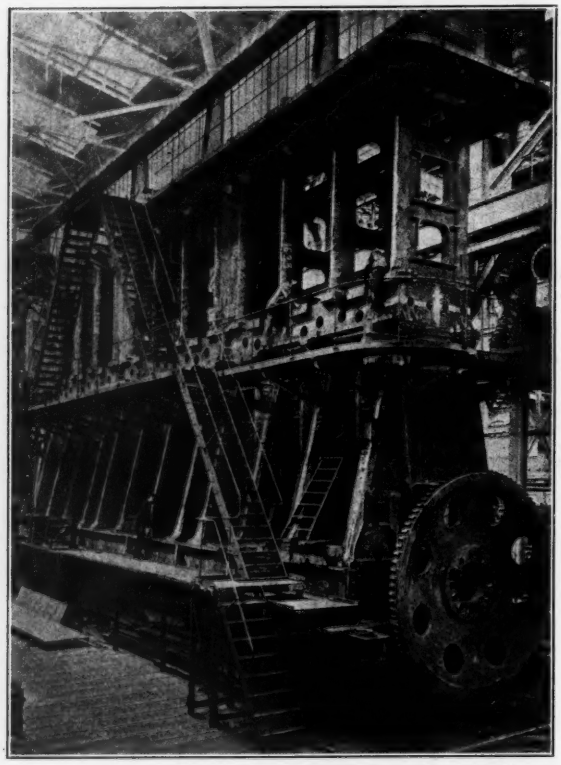


FIG. 4. AS THE ENGINE APPEARED DURING ERECTION. NOTE SIZE OF THE MAN ON LOWEST PLATFORM

mounted on the overhung end of the armature shaft. Scavenging air is taken from outside the building to a filter chamber with provision to prevent water from entering. Motors for driving the scavenging air compressors and other auxiliaries are of the induction type driving through flexible couplings and started by use of water resistances which are also used to control the speed of the motors.

For the data and illustrations of the article, we are indebted to Engineering of London, England.

CONSTRUCTION WORK is progressing rapidly on the big Lake Lure Dam at Chimney Rock, western North Carolina, according to the engineers, Mees & Mees, Charlotte, N. C. This dam will form a 1500-acre lake, a part of a mountain lake resort development; power from this lake will be generated at an automatic hydroelectric station controlled by lake level and having an initial capacity of about 5000 hp.

Fundament Diesel Characteristics Important

POOR MAINTENANCE AND OVERLOADS RESPONSIBLE FOR MANY DIESEL ENGINE DIFFICULTIES. BY J. J. McDOUGALL

CONTINUED observation and operation of the Diesel engine brings out certain fundamental characteristics which should not be overlooked. When in first-class order, operating under conditions for which designed, operation of Diesel engines is practically automatic and requires little or no attention. It must be remembered, however, that various parts wear or get out of adjustment as they do in other machines and failure to realize this has resulted in many engines being wrecked. High pressure and temperature stresses cause slight misadjustments, or wear, to develop rapidly into serious trouble unless a skilled attendant is at hand to give immediate attention to the matter.

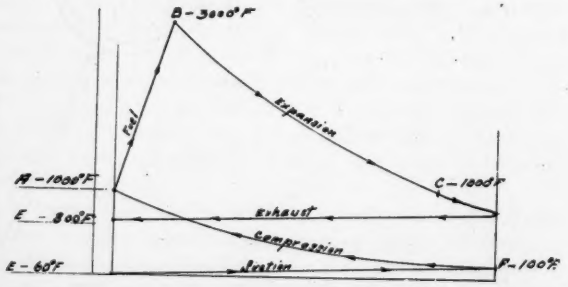


FIG. 1. DIAGRAM OF TEMPERATURES DEVELOPED IN DIESEL CYLINDER AT FULL LOAD

As in the case of a steam plant, skilled operating crews are necessary although a crew that is capable of properly maintaining a steam plant can handle a Diesel plant as soon as they become familiar with various engine parts and maintenance features. Given complete data on the steam engine, a good operator can tell whether or not it will pull the rated load or determine the overload possible without danger of damaging the engine. When the valves are in bad shape or out of adjustment, pistons, piston rods and valve stems leaking, and valve gear worn, he can make adjustments to take care of these matters until it is possible to take the engine out of service for repairs. In such cases a high fuel cost is more than offset by the fact that service is not interrupted. Experienced operators can make the same calculations for a Diesel and in an emergency make adjustments, or nurse the engine along, to keep it running safely until repairs can be made. Fuel consumption and maintenance work is, of course, increased but service is continuous. In the same position an unskilled man might wreck the engine in a few minutes.

ENGINE RATING DEPENDS SOMEWHAT ON SERVICE

Ratings of similar engines vary somewhat with the service. If driving a pump, full load rating is required at all times regardless of speed, so the m.e.p. on these engines is usually lower than with a variable load as in an electric light plant. Occasionally, constant load engines of this type are rated close to the maximum so

that maintenance work must be frequent and accurate, or, slow speed will be impossible and high speed dangerous. One particular engine, direct connected to a 6500 cu. ft. compressor has a normal speed of 180 r.p.m. and a safe operating range of from 65 to 215 r.p.m. When carefully adjusted and well maintained, operating 18 hr. a day, six days a week, 100 per cent of the necessary running time is almost a certainty, although at certain speeds, vibration must be carefully watched. After periods of continuous operation the safe speed range is reduced to from 120 to 180 r.p.m. while the piston and liner wear seems to increase rapidly at these lower speeds.

Diesel Overloads Cause Serious Difficulties

Diesels running at reduced load offer few difficulties, although they may refuse to pull their load when called upon to do so, unless carefully maintained. Under full load or overload conditions, complications arise, however, and it is sometimes difficult for a steam engineer to understand why this happens. Ten per cent overload to a steam engineer is a small amount and many would be pleased if their lightest load was not more than that.

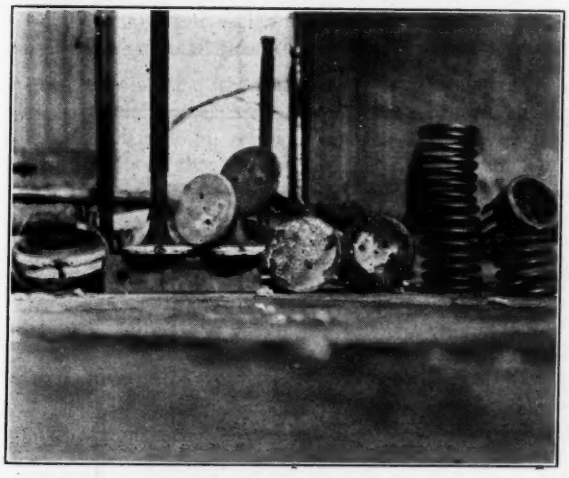


FIG. 2. VALVE FAILURES CAUSED BY POOR MAINTENANCE AND EXCESSIVE HEATING DURING OVERLOADS

Many Diesels are designed so that from 10 to 25 per cent overload can be carried for short periods but momentary overloads above this usually means a different design of fuel cams and possibly a change in the fuel valve. Normal cards have a cutoff of about 1/10 stroke, the range of the governor extending to about 1/7.

Engines designed for pulling high momentary overloads can be quickly put out of commission by pulling this overload for a few minutes although damages may not always show up quickly. Heat stresses set up in metals, highly heated on one side and cool on the other, cause cracks in heads, jackets and pistons which may develop slowly but later result in expensive replacements. Temperatures to which a cylinder is subjected at about full load are shown on Fig. 1. As the engine rating is increased temperatures increase rapidly, greatly exceeding the values given.

Engines which will not pull their rated load are usually found to have leaky valves, leaky pistons, throttled air suction or excessive back pressure. In this connection a study of the low pressure indicator card is of value. This card taken with low scale spring shows only the exhaust and suction strokes.

Indicator cards are taken in the same way as on a steam engine and if the reducing motion is accurate good results may be obtained from its use. It is not used in oil engine work to find the power output of an engine to the extent that it is in steam but more to give the operator a check on the compression, or maximum pressure, developed in the cylinder, the action of the fuel valves, the way fuel is being burned and scavenging of the cylinder. Up-to-date engines have two indicator motions, one following the piston, the other leading or lagging the piston by 90 deg. The latter is used to give a distorted card valuable in checking engine operation, especially the action of the fuel and fuel valves while the machine is in operation.

Leaks Should Be Plugged

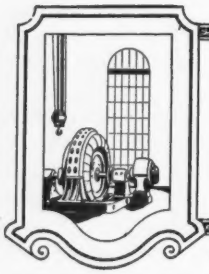
By W. F. Schaphorst

WHY AREN'T barrels of oil allowed to leak in and around a plant? Simply because we don't like to have oil on the floor and because of the value of the oil. We all know the answer, but it is an illustration of little things. If there were a little round hole in a barrel of oil, unless it was plugged the oil would all leak out in a day. A plug which would fit the hole and stop the leak would cost a dime and, surely, anyone would invest a dime and save anywhere from $5 to $10. The plug would be a good investment.

One peculiar thing is that we gladly buy preventives when we can see that the preventive is actually doing something. We can see oil with the naked eye but, when it comes to purchasing something for the elimination of friction losses, we hesitate. We cannot see friction, therefore we get along with plain bearings in important places where ball or roller bearings would be better, refuse to spend a little more for a better lubricant and rebabbit bearings only after they give so much trouble that the wheels cannot be kept going.

We can see the results of these leaks, if we go out in the coal yard and look at the coal pile, but the relation is not so evident as in the case of the oil barrel. Nevertheless, it is there and we ought to go out and look at that coal pile oftener. It will pay to spend just a little money for plugs such as ball and roller bearings, better lubricating oil, better shaft alinement, belt dressing and proper belt care in order to stop up these friction leaks. We know that belt slip is a loss but slipping of a loose pulley is just as important and the cost is the same for each per cent of slip.

THERE'S NOT much credit in being boss when everything is lovely and times are prosperous. The real test of ability is guiding the Ship of Commerce through troubled waters and hidden dangers. Otherwise presidents and managers should not receive more than common labor; for without the need of ability prices would remain uniform and conditions would be stagnant though stable.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Use of the Power Loop in Industrial Wiring

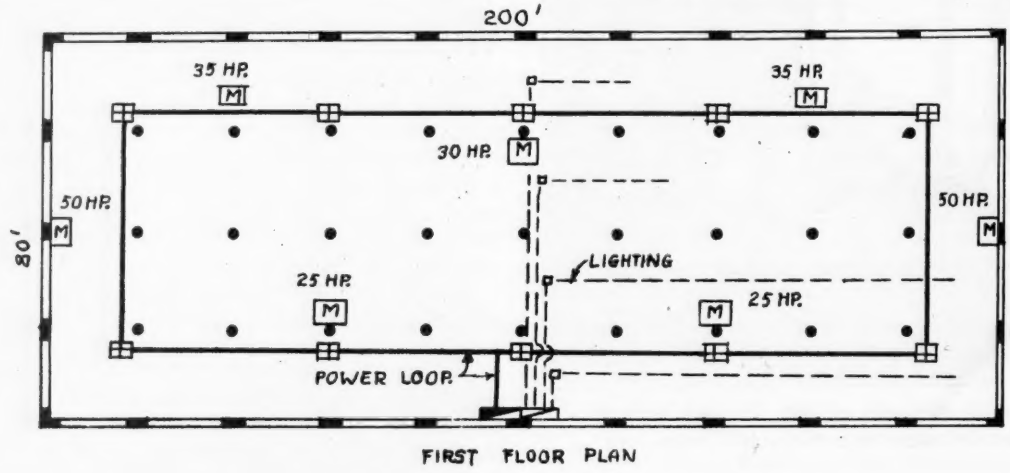
METHOD OF WIRING DEVELOPED TO SAVE TIME IN WAR WORK HAS MANY ADVANTAGES. BY MORGAN G. FARRELL

DURING THE high speed construction period of the war-order days, a system of wiring for factories was developed by a few progressive contractors which had so much to commend it that it is surprising to find that it has not become established practice.

The power loop was devised primarily as a time-saver. When any manufacturer could secure big orders if he could expand his plant fast enough to turn out production in sufficient volume, construction short-cuts often became decisive factors. The leisurely methods of ordinary times would not do. Buildings were put up with record-breaking speed. Machines and tools were ordered so that they would be on hand when the new plant was ready to receive them. The layouts of the departments were sketchy—details could be worked out while the equipment was on the way. Even when the buildings were completed and the tools were in the storage sheds, radical changes in the order and arrangement of the shop-rooms were still being made.

All this time the electrical plans were still untouched. Nothing could be done with them until the tools and motors had been located. Then it took another month or two to get the mains, conduit, wiring, panels and the rest, installed.

As likely as not, further changes would be found necessary after the whole job had been finished. Lines would be ripped out again and re-arranged or scrapped if they could not be used. The direct money loss, though considerable, was far less important than the indirect loss due to wasted time in starting production.



HEAVY TOOL FLOOR OF A MACHINE SHOP SHOWING THE POWER LOOP AND ITS RELATION TO THE FIVE PRINCIPAL MOTORS

Somehow the conservative engineers did not at first seem to be able to get away from cut-and-dried methods. If it was a concrete building, (and it usually was, for steel was hard to obtain) the lighting system was laid out, so many outlets to a bay, the concrete pouring was held up until all conduit had been placed on the forms and nothing whatever was done on the power layout until the machinery plan was decided upon.

POWER LOOP WAS DEVELOPED TO SAVE TIME

At length two or three of the more enterprising engineer-contractors got together and evolved a method by which the power lines would be ready for use as soon as the building was finished—regardless of the final details of tool placement. To illustrate how it was done and how it can still be applied, consider the conditions confronting plant executives who plan additions without being quite certain of all the details. The many

minds to be consulted agree on one thing: that it will take six months to finish the building work, that the sooner it is begun the better, and that there is nothing to be gained by waiting until every part of the equipment is selected. The electrician groans when he thinks of his enforced idleness until he gets word to go ahead and of the 24-hr. sessions ahead of him then.

Now, however uncertain a superintendent or production engineer may be regarding the exact location of all the machinery on any floor of a factory, he is sure at least of the machines which will be assigned to each floor and of the total horsepower required to drive them. That is all the information needed by the electrician if the loop system of wiring is to be used. Let us assume that a four-story machine shop 80 by 200 ft. has been laid out thus:

1. First floor: Planers, Boring Mills, etc.	Total hp.	500
2. Second floor: Lathes, Shapers, Millers	" "	300
3. Third floor: Drills, Automatics.....	" "	200
4. Fourth floor: Small Tools.....	" "	100
Total Connected hp.		1100

Assume also that the load factor is 50 per cent, i.e. that the actual motor horsepower for the four floors is 250, 150, 100 and 50 respectively, the total being 550. Outside mains of that capacity, plus a 25 per cent overload allowance, are brought to the building during construction.

As soon as the forms are removed, a riser (more than one in a large building) is run. In it are the vertical wires of sufficient capacity to supply 550 hp. (plus overload) to the first floor level, 300 hp. to the second, 150 hp. to the third and 50 hp. to the fourth. At each floor is a panel containing only a circuit-breaker or oil switch with low-voltage release and overload relay of a capacity equal to the floor motor-hp. (always plus the 25 per cent allowance).

From the circuit breaker on each floor a conduit-wire-loop of a capacity equal to *half* the motor load of the floor is run around the room, starting at and returning to the breaker terminals. The conduit is suspended from hook bolts screwed into inserts placed in position on the forms before the concrete is poured. The loop encircles the outer rows of columns close to their heads. At intervals of 20 to 40 ft. junction boxes are set in the loop.

Thus, in the building used as an example, if the columns are 20 ft. apart both ways, and the junction boxes are 40 ft. apart, there will be ten junction boxes in all on each floor, none of which is over 20 ft. from any possible motor position, on that floor. The whole distribution system will be in place before the finishing touches have been given the building itself. The only work remaining to be done is the connection between the motors and compensators (after their sizes and locations have been decided) and the nearest junction boxes in the loop.

The economy of time is obvious. But the greatest advantage of the system is its flexibility. The motors can be of any horsepower, and in any number within the total capacity allowed for the floor, and they can be placed anywhere. Generally the compensator will be mounted on the side-walls or on a column with the motor itself (a) hung from the ceiling nearby or (b) placed on a suspended platform or (c) directly connected to a machine. In any case the run from the junction box will be short. A motor can be taken down and moved without any loss of conduit or wiring since the runs will be about the same for the new position. A small amount of bending, straightening or trimming is all that is needed to make the new connection.

Full Horsepower Available at All Points of the Floor

The principle of the loop is that the full horsepower is made available at any point on the floor, through the two closed branches from the circuit breaker, each having a capacity equal to half the floor motor load. So that, if a 250-hp. motor is installed in one part of the floor, thereby using up the full capacity of the feeder to the circuit breaker, the operating current to supply the motor splits, part of it passing through the right branch of the loop and part through the left branch uniting again at the motor connection. If the motor is near the centre of the floor, the division of current will be about equal since the resistances of both branches of the loop are equal. But if the motor is at one end of the room, the resistances will be unequal. This is a highly exceptional case and calls for a "jumper" across the loop to shorten the travel through its longer branch.

Ordinarily, there will be several motors at least, scattered about the room so that the loop will be tapped at approximately equal intervals for connections of varied capacities. (Capacity is here used in a sense of power demand and not in the strictly electrical sense.)

Still more commonly, the motor equipment required for a large room full of machines of various sizes will be even more varied in horsepower. For instance, on the third floor of the machine shop under consideration, the machine-tool equipment includes drills of various sizes, automatic-screw machines and the like calling in all for 100 hp. In such a room it would be good practice to use group drive for the drills and individual motors for the automatics. Moreover, the groups of small drills would call for a motor of comparatively small horsepower, while a group of multiple drills would require a much larger motor.

However the machines may be arranged on the floor, it is evidently an easy matter so to arrange the loop taps that each would be of approximately the same capacity, governed by the size of the largest motor. For instance, if the multiple drill group required a 25-hp. motor and each group of single drill presses demanded 7.5 hp., one 22.5-hp. tap with three branches would be the proper connection. In the same manner, the individual direct connected motors of the automatics would be grouped on the single tap approximating 25 hp.

Such an equalization of the load on both branches of the loop can generally be worked out, but where it would involve a sacrifice in the arrangement of the tools or motors, it is preferable to leave the loop somewhat unbalanced, for motors are rarely operated at full load in most machine rooms, so that there is always sufficient reserve copper available in the loop circuit to take care of a considerable inequality in the branch loadings. The drawing illustrates the main features of the first floor layout already discussed. It will be seen that motors

have been placed symmetrically about the shorter center line of the building so that the question of unequal load does not arise. The plan also shows the location of the panel board to which we will refer later, and the loop and its junction boxes as well as the motors.

At this point the question of first cost naturally arises. Is it cheaper to install a heavy loop of sufficient capacity to take care of the full floor load at any point or points than it would be to install a distributing panel with switch-controlled and fused branch circuits running from the panel to each individual motor? The following table summarizes the circuits and connections required in each case.

LINEAL FEET OF CONDUIT AND CABLE REQUIRED

Horsepower	25	30	35	50	125	250	Total
Loop Distrib.					416	22	438
Panel Distrib. ...	132	64	252	292			740

PANEL REQUIREMENTS

Loop Panel	1 250-hp. circuit breaker
Distributing Panel	1 250-hp. circuit breaker
	2 50-hp. fused switches
	2 35-hp. fused switches
	1 30-hp. fused switch
	2 25-hp. fused switches

Connections in and around the motor and compensator units will cost the same in either case so that they may be disregarded in a comparison. The reader may price the circuit runs given according to his own record of costs. It is impossible to give specific figures since they necessarily vary according to the grade of wire and fittings as well as the type of construction of the building. The labor cost will vary even more widely. Contractors' prices will differ among themselves and all of them will be higher than the cost of the job done by the plant electrician. The experience collected from a number of installations indicates that the loop system will cost more where it serves only a few large motors at wide intervals of spacing and less where there are numerous small motors to be supplied with current.

In the long run, however, the loop system will be far cheaper for there are few lay-outs of machinery which are not changed at fairly frequent intervals.

In shoe plants for example, all the machines are placed in a belt extending around the entire floor adjoining the windows and not much more than 10 ft. wide. On account of the changing styles, the shoe machinery layout will not stay put for more than a year. K. D. Hamilton, Mechanical Engineer of the George E. Keith Co., makers of the famous "Walkover" shoes says that machine layout is sometimes changed several times in one year and that the utmost flexibility of floor construction and wiring arrangement are necessary to keep the expense of changes from becoming prohibitive. In plants of this and similar industries, the loop will save its cost many times over, since it remains permanently placed, the only changes being the removal and re-installation of the short branch circuits between the loop and the motors.

Another decided advantage is that the copper cross section can be increased to give a considerable reserve for future motors without greatly increasing the first cost. Anyone who is familiar with the duplication of feeders and distributing panels in textile mills caused by the addition of new machines for which no provision was made in the first instance will appreciate that this is so.

LAYOUT OF THE LIGHTING SYSTEM

A modification of the same system is applicable to the lighting layouts of plants in which a great many local lights are required. A common practice of engineers who design reinforced concrete buildings is to bury the conduit for the general lights in the concrete slab. There is no particular objection to this where the process does not call for a large number of local lights at the machines, over work tables, etc., and where the equipment layout is fairly permanent. The arrangement, however, is so inflexible that it would seem to be better in any case to hang all the lighting conduit from the ceiling.

For a job like that illustrated in the cut, where the most efficient lighting is a combination of relatively few general lights, with at least one local light for each machine on each floor, a more flexible system is essential. The loop, of course, would not do for two reasons: (a) It would not permit sufficient control of sections of lights from a central panel and (b) it would not reach all parts of the floor without a great deal of branch circuit work. A form of herringbone distribution as indicated by the dotted lines on the right-hand half of the plan has been found to meet all ordinary requirements. The floor is divided into eight circuits, one for each half of the longitudinal bays of the building. These circuits are controlled by switches on the distributing panel for lighting.

In addition to the outlet boxes for the general lights in the center of each bay, a series of junction boxes are placed in the circuit at intervals roughly corresponding with the number of transverse rows of machines. The sub-circuits serving groups of local lights are taken off at these junction boxes. One electrical contractor has patented a form of outlet box for these sub-circuits which is so arranged that the usual "knockouts" are replaced by screw or plug sockets. Thus a new local light can be permanently or temporarily connected with no further labor than is necessary to insert a screw or push-plug with cord into the receptacle. To insure both flexibility and low cost it is a good plan to standardize on all parts of the power loop and lighting distribution systems which can be so treated.

For instance, it has been found highly desirable to use a combination lighting and power panel of standard design. It is divided into two vertical sections with separate doors. One of them contains the circuit breaker controlling the power loop, and the other contains eight or more switched and fused branch lighting circuits with a single main control switch. These panels are always the same size regardless of the capacity of the circuit breaker. The object, of course, is to insure quick delivery from stock and interchangeability. The only special feature of the panels is the circuit breaker, which with its base can be mounted in a few minutes.

It is pertinent to add that the loop system as worked out in a number of war plants was submitted to some of the insurance companies who approved it with suggestions which added to its usefulness.

Modern Bakery Is Operated Electrically

New Bakery in San Francisco Finds Use for Electricity in All Its Departments. By C. M. Faunce

WITH THE completion of the new California Baking Co.'s plant, which is one of the finest of its kind in the United States, the electric equipment installed is in keeping with the ideal plan carried out by the owners in the matter of efficiency throughout the entire building.

Having in the service 24 Walker electric trucks for delivering bread, the problem as to how these cars could be recharged over night without taking up much of the floor space in the garage was a constant worry to the management. Finally the plan of installing in one corner of the garage two General Electric motor generator sets which do the work required was adopted. These cars are re-charged overnight as they are parked or stored in the stalls which have been provided for loading.

In each of these stalls where the cars are parked has been installed a connection which runs through conduits under the ground and is tied up to the two motor generator sets. Each circuit is controlled by a rheostat which enables the attendant to vary the rate of charging as desired for charging Edison or lead batteries. These charging panels are in sections and tied together by copper bus bar connections. The d. c. generators are rated at 50-kw., 400-amp., 128-v., 1200-r.p.m. and are direct connected to two General Electric 75-hp., 440-v., 3-phase, 60-cycle induction motors. The generator control wires and mains are run in conduits under the cement floor to the electric control panels for the operation of the generators. This general panel is equipped with general protective devices to always protect these trucks against overloading its voltage and also reverse current conditions.

The motors are started by hand operated compensators which also are protected from unusual electrical conditions.

Plant Has Its Own Transformer Vault

In the engine room is located the transformer vault that houses the transformers for power and lighting of the entire building.

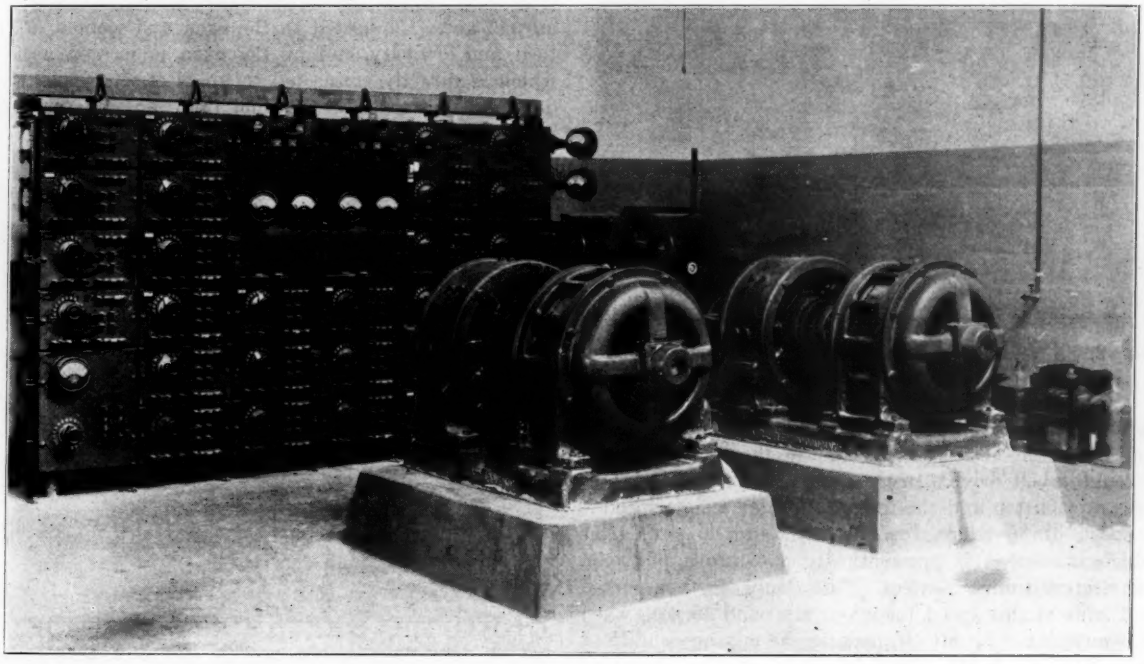


FIG. 1. CHARGING EQUIPMENT FOR RECHARGING THE ELECTRIC TRUCKS

Power is brought in from the outside over the wires of one of the large power companies through two separate 11,000-v. primary feeders, which are connected to two interlocking 11,000-v. oil switches, which also insure an uninterrupted service. Power for these feeders is controlled from two separate or different sources: one from the steam power plant located in San Francisco, and the other from the high tension transmission lines from hydro electric stations in the mountains. From the oil switches, which are located in the vault, the primary feeders are connected to two banks of transformers 150 kv.a. each which step the voltage from 11,000 v. to 440 v. for the industrial power. Low voltage current is carried underground through four cables to the switchboards located in the engine room to control all the lighting and power throughout the entire plant. The lighting throughout is 110-220 v., derived from 3 50-kv.a. transformers which are also located in the vault. From the main power board the main feeders distribute power to the various floors.

A traveling oven installed on the second floor is com-

posed of steel plates which are connected with heavy rollers by pins and links, forming an endless chain. This traveling hearth is driven at the delivery end of the oven through a reduction gear which has a ratio of 230 to 1. This reduction gear drive runs and is also sealed in oil. This drive is connected to an electric 1200-r.p.m., 60-cycle motor, and is connected to a variable speed transmission by a silent chain drive. The transmission varies the time of baking of the traveling oven to any desired time through the use of remote

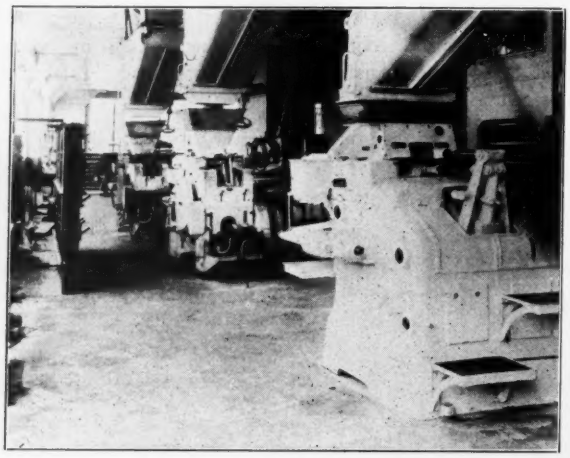


FIG. 2. A GROUP OF MOTOR DRIVEN DIVIDERS. MOTOR CONTROL PANEL IS SHOWN AT THE LEFT

control, push button stations for motors. The reduction drive for the oven is connected to the variable speed through a belt drive. In the mixing room the attendant presses a button and the mixers move at a slow speed—a speed of 35 r.p.m. for one min. and 45 sec., after which the speed is automatically cut into a 65-r.p.m. by electric timing devices. The dough is then mixed and runs at this speed for seven min. and 45 sec., when it is automatically cut off, making the mixing conditions constant. After the mixer has stopped, the attendant presses another button and a separate motive drive tilts the mixer bowl into the desired position, discharging the dough into a dough trough.

All machinery in the plant is operated by remote control, using automatic push buttons, with compensators for the larger motors, and the 7006 D-4 General Electric automatic electric contactors. These contactors are mounted on the distributing boards in order to be easily accessible at all times, the push button stations being grouped in convenient units that operate the machines.

The lighting throughout the plant has been given the most thorough consideration, not only from the standpoint of efficiency but beauty as well. Run in separate units from the main switchboard on each floor each line is controlled by a chain socket so the entire floor does not have to be lighted at one time but can be controlled as desired.

The ovens are fully protected by a magneto valve on the main header which is controlled by an electric lighter on the top of the oven near this main header valve. This lighter is driven by a small motor directly connected to the high tension magneto. The high tension current from the magneto is distributed to a revolving arm making a jump spark connection to 96 contact points, which causes a spark to appear at the spark plug connection to the burner once every 7 sec. This automatic lighter runs all the time when oven is in operation and when shut down, the lighter is immediately cut out.

If the current for some reason is automatically shut off, the gas compressor is shut down, shutting off the supply to the burners. The automatic lighter stops, cutting off current to the magneto valve. When the current is shut off the magneto valve closes the main header valve. Therefore, prior to relighting the oven, the automatic lighter must be started before the magneto valve can be opened. This safety device eliminates any possibility of the baking chambers filling up with unburned gas. Connected to the oven and located at the feed and delivery end of the oven is located a hood which is directly connected to an electric exhaust fan, drawing off burned gases from the oven and discharging them to the outside air.

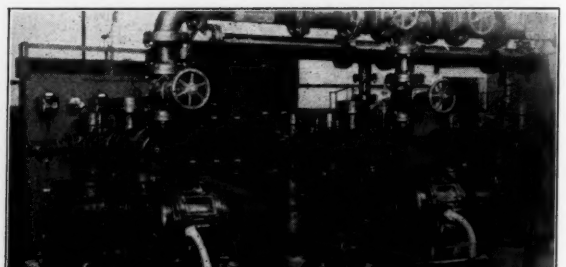


FIG. 3. ELECTRIC MOTOR DRIVEN GAS COMPRESSORS FOR THE OVENS. MAIN SWITCHBOARD IN REAR

No part of this equipment of electric devices has been overlooked for efficiency from the charging of the electric trucks to the lighting of the building and running of the machinery.

Man labor is eliminated to a large degree and efficient machinery installed to keep the direct flow moving to the finished product—bread.

Prizes for Merchandising

TO STIMULATE improvement in the methods of distributing merchandise, Edward N. Hurley, Chairman of the Executive Committee of the Electric Household Utilities Corp., is offering, through the Commercial National Section of the National Electric Light Association, three prizes of $5000, $3000 and $2000 for successful merchandising efforts of operating companies.

Conditions of the contest are that contestants must be electric light and power operating companies, members of the N. E. L. A., and prizes will be awarded to companies operating in individual cities, or to groups of ad-

jacent companies operated as one local system. Holding companies as such are not eligible but their subsidiaries may compete either individually or as groups. Merchandising activities shall have been inaugurated not later than January 1, 1925, and at least one store, or display room shall have been established. The basis for award will be the net profit shown on merchandise sold at retail; the beneficial effect on the public and trade good will; increase in kilowatt-hours per average residential consumer; and the winning companies are to distribute the awards among those of their employes who, in their judgment, have been concerned with the merchandising activities which won the various prizes and those employes who helped in preparing the data submitted.

The plan submitted must have had at least six months practical operation in 1926 and, in the application, there must be given the annual sales of household electrical appliances in dollars; the number of wired homes on the reporting system; the extent to which sales are due to resale crews furnished wholly or in part by manufacturers or others outside the central station organization; the annual sales of non-electrical merchandise; the net merchandising profits based on the average capital employed in the merchandising; increase in kilowatt-hours sold to the average residential customer; gain in public and trade good will and in other retail lines.

All matter must be at the Association headquarters on or before February 1, 1927, enclosed in a blank sealed envelope which in turn shall be enclosed in another envelope, bearing the name of the contestant and the words ' Competition for Hurley Award'' and addressed to National Electric Light Association, 29 W. 39th St., New York City.

Any further information desired can be obtained from George F. Oxley, director of Department of Public Information, at the above address.

Generator Sizes Make Big Jump

WITHIN the memory of even young men, the first "giant turbine," a vertical unit rated at 5000 kw., was built by General Electric Co., for the Commonwealth Edison Co., and installed in the Fisk Street station in 1903. That turbine, the first large one built by the General Electric Co., has long since been withdrawn from service to make way for larger units, and now has the place of honor as a monument in front of the turbine shops in Schenectady.

Progress that has been made since that time is hardly conceivable. Two years ago, the first 60,000-kw. turbine was put in service by the Commonwealth Edison Co., at its Crawford Ave. Station. This was followed by a 77,000-kw. unit and a 91,500-kw. unit is now being built for the same station, all these being of General Electric manufacture.

Now comes the announcement that within 18 months a turbine generator unit rated at 208,000 kw., or nearly 280,000 hp., is to be supplied. This again is being manufactured by the General Electric Co., as the first unit for a 1,000,000-kw. station, to be built by the State Line Generating Co. on the Lake Michigan shore, near the Indiana-Illinois state line. This unit will have a 76,000-kw., high-pressure element, taking steam at 600 lb. pressure and 730 deg. F. and exhausting to two low-pressure elements of 66,000-kw. each. Each element will run at 1800 r.p.m. and generate current at 18,000 v., with connections so made that the sections can be operated independently when desired. Between the high-pressure element and the low pressure, steam will be reheated, by passing through a heater using live steam, to a temperature of 500 deg. F. To each of the low-pressure units is attached a 4000-kw. service generator.

Complete weight of the machine will approximate 4,000,000 lb., the heaviest individual part weighing 275,000 lb. The rated capacity of this one unit is 63 per cent that of the Niagara Falls Power Co.'s entire hydro electric generating station. It will consume more than two tons of low grade coal each minute and 400,000 gal. of cooling water will be pumped from and back into Lake Michigan each minute. The air breathed will total 350,000 cu. ft. a minute for cooling the generators.

This plant marks a new era in power production, not only because it is many times larger than any steam operated electric plant now in existence but because it will serve exclusively as a producer and wholesaler of electricity. Its output will be sold to inter-connected power companies of the Chicago-Illinois-Indiana district, including the Commonwealth Edison Co., Public Service Co. of Northern Illinois, Northern Indiana Public Service Co., and Interstate Public Service Co., which together form what was termed by the late Dr. C. P. Steinmetz as the greatest power pool in the world.

90,000-Kw. Units

Not only in the middle west, but in the far west is the demand for big capacity growing. Southern California Edison Co. has ordered for its system two 90,000-kw. turbine generator units at 90 per cent power factor, these being the largest in both capacity and physical dimensions, since the arrangement will have tandem-compound turbines, driving a single generator on the same shaft.

Two unusual features are that the armatures will be of special heavy construction so as to be gas-tight for possible future adoption of the new system of hydrogen cooling. The other feature is that a double-flow, low-pressure end and four vertical condensers will be combined giving simplified foundation and increased space for removal of condenser tubes.

Each armature, which will weigh 330,000 lb., will be of such size that it must be assembled at Los Angeles. Railroad cars with a capacity of 165 tons are not available, and shipment by rail would be impossible because of track, bridge and tunnel clearances. The heaviest pieces to be shipped, the revolving fields of the main generator, will weigh 230,000 lb. each.

Total weight of each unit will be 1,650,000 lb., the length of the turbine generator being 103 ft. each. Turbines will run at 1500 r.p.m. and the current will be generated at 16,500 v. On the same shaft with the main generator will be mounted a house service generator rated at 4,000 kw. at 80 per cent power factor. Turbines will take steam at 400 lb. gage pressure and at a total temperature of 725 deg. F., exhaust being at a pressure of one inch absolute, so that practically all the energy is extracted from the steam. Boilers will be fired with either natural gas or oil.

Swiss Test New Propeller Type Runner

DRAFT TUBE DESIGN PROVES IMPORTANT IN HIGH SPEED INSTALLATION AT MATTE POWER STATION, BERNE, SWITZERLAND. BY F. JOHNSTONE-TAYLOR

PROPELLER TYPE RUNNERS of the Nagler, Kaplan and Lawaczeck designs are now well established and one or other of them appear to fulfill most requirements of low or variable head installations. However, the work of Dr. F. Prasil of Zurich involves yet another type of runner of interest both because of the shape of the runner and the form of draft best suited to it.

In conformity with accepted practice in hydraulic turbine design, a comprehensive series of experiments

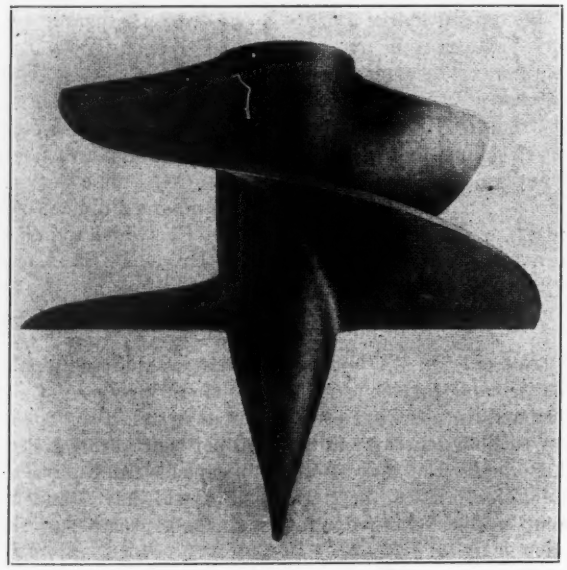


FIG. 1. VIEW OF THE NEW PRASIL RUNNER AS INSTALLED IN THE MATTE STATION

were made upon models and while there were some differences in the actual form of the various runners tested, a design similar to Fig. 1 was finally adopted for the full size plant with the turbine set as in Fig. 2. Models with an overall diameter of 6½ in. and 19⅝ in. were used for the tests, the former being arranged for visual observation through glass, the latter set in a spiral concrete casing with 12 guides of the Francis pattern. All models functioned in a satisfactory manner so far as the runners were concerned, the runaway speed of the larger model under a head of 33 ft. was determined to be 2600 r.p.m. Bursting tests were carried out with the runner suitably protected by sandbags speeded up by an electric motor. Fracture took place at about 5500 r.p.m. three out of the four tests to destruction showing good fractures, the metal from them showing a tensile strength of 34,000 lb. per sq. in.

Full size turbines designed from the results of these tests are in operation at the Matte Power Station, Berne, Switzerland. The 63-in. runners are designed to operate under a head varying from 8 ft. 2 in. to 11 ft. 4 in. and develop a maximum of 323 hp. at 250 r.p.m. with the higher head. Draft tubes, Fig. 3a, suitable for the models were unsuited to the full size plant on account of the low head so a modified type shown in Fig. 3b was tried with the model. A loss of 4 per cent efficiency became 20 per cent in the full size plant resulting in further investigations on model tubes to ascertain where the trouble lay. This was finally located in the horizontal leg, which later was altered to the form shown in Fig. 3c, the arrangement finally adopted as it gave good results, although not equal to those obtained by the original form.

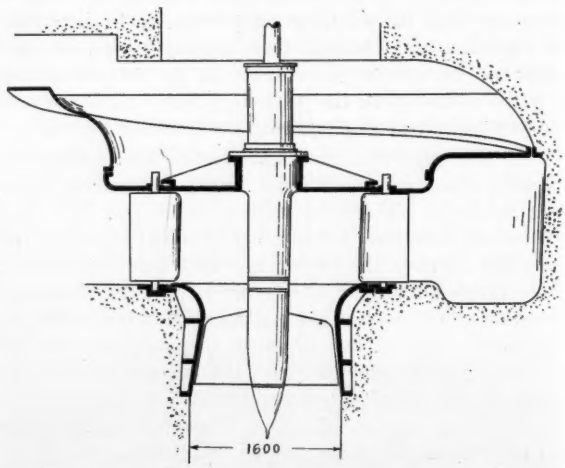


FIG. 2. CROSS SECTION OF THE TURBINE SETTING WITH SPIRAL CONCRETE CASE

Three old Jonval wheels replaced in the Matte plant developed but 130 hp. each at 28 r.p.m. while under exactly similar conditions the new turbines develop 320 hp. each at about 240 r.p.m. according to the head. For tests current meters had to be relied upon while a friction brake was erected for measuring the power.

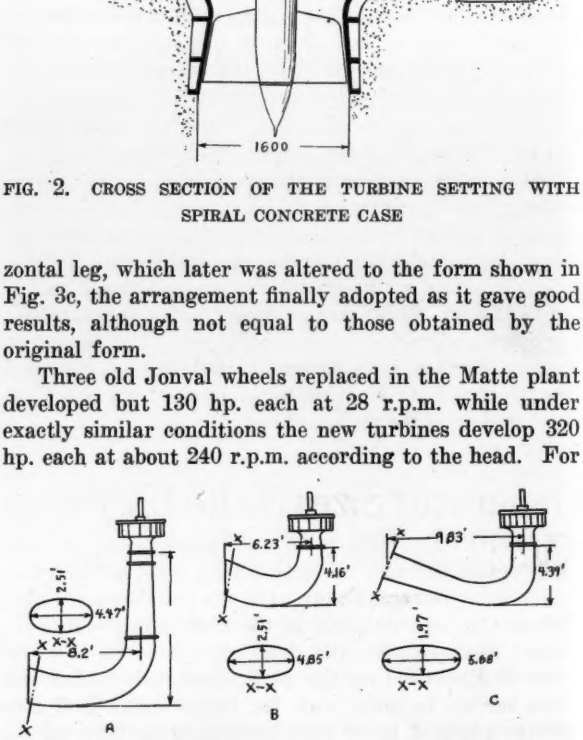


FIG. 3. VARIOUS FORMS OF DRAFT TUBES TESTED IN AN EFFORT TO GET MAXIMUM EFFICIENCY

In an article in the Schweizerische Bauzeitung, Dr. Prasil gives a large number of curves and figures from which the tabulated summary was taken. In view of the very high speeds obtained the tests prove the value of this type of runner for small and moderate powered turbines required to operate under low and variable heads.

Head, ft.	5.70	5.76	5.74	5.86
Discharge, sec. ft.	2.35	18.9	24.7	20.7
Speed, r.p.m.	205.0	147.3	200.4	149.4
Efficiency, per cent	76.5	83.0	74.9	80.1

Steam Distribution Lines at Rochester

CONSTRUCTION OPERATIONS INVOLVED IN FURNISHING CITY WITH HEAT FROM CENTRAL STATION. BY E. R. BENEDICT

"CHESTNUT Street right now is afflicted with growing pains," said Commissioner of Public Works Harold Baker. "Now this steam heating plant will mean much in the future of business in Rochester, as it will save coal burning downtown, and that will mean less ash collections for the city. There may be more inconvenience in this particular neighborhood in the next six months, but in the end, it will mean a saving to the taxpayers."

With this attitude from the city administration and general public, construction operations were begun May 1, 1925, on the first line of steam mains from the new heating plant in Lawn Street, known as Station 8, and owned and operated by the Rochester Gas & Electric Corp.

This work consisted of installing a system to supply steam service to consumers in the rapidly developing "uptown" business section of Rochester. A steam generation plant was built in Lawn St. The boilers in this plant are built to produce steam at a pressure of 375 lb. and a temperature of 550 deg. using pulverized coal as fuel, each boiler being rated at 180,000 lb. of steam an hour. A turbo-generator electric unit has been installed which will act as a reducing valve supplying low pressure steam to the distribution system. This is a case of electric energy becoming a by-product of a steam heating plant.

The distribution system which was installed by the American District Steam Co., consisted of three pipes in a concrete conduit arranged as is shown in Fig. 1. The large pipe carries low pressure steam for heating and will be operated only during the heating months. The smaller insulated pipe carries high pressure steam for heating water, cooking, processing, or any other purpose for which a consumer may want steam. The third pipe is to conduct the condensate water back to the heating plant from the consumer and is known as the "return."

LENGTH OF RUN IS 3829 FT.

Mains installed in 1925, run from the new plant in Lawn Street to Chestnut Street, North to Euclid Street. In Euclid to a private right of way through the East Ave. Bldg., thence in East Ave. to Stillson, in Stillson to Achilles, and thence in Achilles to the Baptist Temple.

From the intersection of Lawn and Chestnut Street, a line goes South to Temple, in Temple to Cortland, from Cortland through a private right of way in Clinton Avenue to Jackson Park, to Stone Street, thence in Stone Street, terminating at the new Lincoln Alliance Bank Building at Main Street. The low pressure pipe in this system varies in size from 24 in. maximum to 8 in. minimum. The high pressure line has maximum size of 8 in. and minimum of 2 in. The return line also has a maximum size of 8 in. and a minimum of 2½ in. The total length of run is 3829 ft., or total pipe length of 11,487 ft. The low pressure main is of standard weight steel pipe and is insulated with 2 in. of all asbestos imperial pipe covering, provided with ¼-in. inner lining of silica soda to withstand a working temperature of 550 deg. F. The high pressure is of extra heavy steel pipe insulated with 3 in. of all asbestos imperial superheat insulation. Return main is of extra heavy wrought iron pipe. This also has inner lining of ¼-in. silica soda to withstand working temperature of 550 deg. It has been found that the amount of heat remaining in the condensate, after passing through the customers' system, does not warrant the added expense of covering this line. Therefore, the return line is not covered.

Trenching required for this construction was done by C. P. Ward, Inc., who used pneumatic tools for breaking the pavement and spading the earth, making it possible to remove with hand shovels. The trench dimensions varied from 5½ ft. to 4 ft. in width, and from 5 ft. to 15 ft. in depth. At many of the street intersections, or

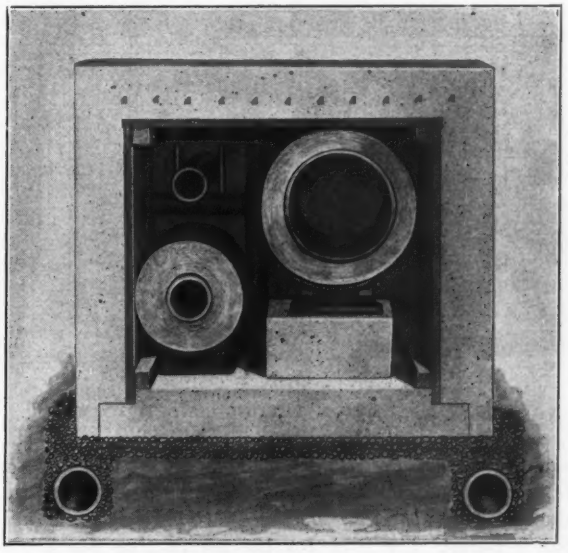


FIG. 1. CROSS SECTION MODEL OF A STEAM PIPE CONDUIT

in making street crossings, it was necessary to tunnel under the thoroughfares so as not to obstruct traffic. In back filling, pneumatic rams were used to tamp the earth into place so that the cuts in the pavement could be repaved at once. The under drainage for this system consisted of two 4-in. farm drain tiles laid parallel in two ditches at the bottom of the main trench, as is shown on Fig. 1. This tile was then covered to a depth of 2 in. with No. 2 washed gravel. At low points and other convenient places these under-drainage tiles were run into the city's sewers, and connected with the back water trap so that at no time can the under-drainage system be flooded by water backing up from the city drainage system.

Upon this gravel under drainage the concrete base with an average thickness of 6 in. was laid. This base was constructed as is shown on the accompanying sketch with a double key or shoulder on the outside edge so that the sides of the conduit wall was interlocked with the base. The concrete for this base consisted of a mix-

ture of one part Portland cement, two parts of washed sand and four parts of one inch washed gravel. This was mixed to a quaking mass and laid with a finished surface to an absolute uniform grade. This grade is determined by setting grade stakes at 10 ft. intervals in the run from fitting to fitting. Concrete blocks of this same mixture were made and set as piers at intervals of about 15 ft. to support the low pressure main, as is shown in Fig. 1.

After the concrete base had taken its initial set and become sufficiently dry to allow it to be walked upon, the high pressure and low pressure pipes, which had received a coat of rust and corrosion proof paint, were lowered into place and made ready for welding. The high and low pressure pipes were of steel and manufactured by Spang Chalfant & Co. The low pressure pipe was of standard weight, or ⅜ in. thick for O. D. sizes, and the high pressure, extra heavy, or ½ in. thick. The ends on all the pipe were beveled at the mill for welding. The pipe for the return line was all of extra heavy thickness, wrought iron, and made by the Reading Iron Co.

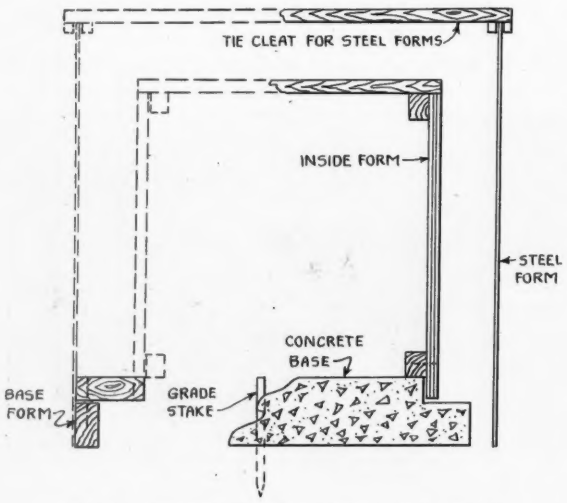


FIG. 2. METHOD OF SETTING CONDUIT FORMS

Welding and Testing Pipe Joints

In preparing for welding the pipe was set upon rollers to facilitate the turning of the pipe as the welding progressed. The welding was done entirely by electric-arc process, Wanamaker mild steel electrodes being used for the filler metal. The current was supplied from welding generators mounted upon tractors. This made a mobile unit which greatly facilitated the work. The welding required on this job amounted to 23,547 lineal inches. The operators used on this work were men trained on pressure pipe welding and, as a result, very few leaks occurred.

As the welding on each section was completed the ends of the line were blanked off with steel plates by welding them in, the plates were ⅝ in. thick and reinforced with tee iron. The lines were then filled with water and pumped up to a hydraulic pressure of 700 lb. While subjected to this hydraulic pressure, a thorough hammer or impact test was given to each welded joint. This impact test consisted of striking the pipe on both sides of the welded seam with a sharp vibratory blow, with a 3 or 4-lb. hammer, with a handle similar to a blacksmith's striking hammer. The blows were struck 2 or 3 in. apart and within 2 or 3 in. of and on each side of the seam. The blows were as rapid as a man could conveniently strike a sharp swinging blow, and as hard as could be struck without indenting or distorting the metal of the pipe. It was discovered that capillary leaks, or "sweats," would develop at a pressure of 700 lb. which did not show at a pressure of 500 lb. Leaks of this kind were corrected either by peening or cutting out some of the metal of the weld and rewelding.

Details of Pipe Insulation

After all the welds had been found to be perfectly tight, they were given a coat of rust and corrosion proof paint and application of the insulation was begun. The insulation for the low pressure main consisted of 2 in. of all asbestos pipe covering. This covering was made up of two 1 in. thick layers and applied with the broken joint method. That is, the inside cover was applied to the pipe and wired fast with two bands of No. 16 gage soft annealed iron wire, then the outer covering applied so as to cover the joints in the inner covering. This outside covering carried a 30-lb. water proof asphalt jacket, and was also wired fast with two bands of 16-gage soft annealed iron wire. The lap on the asphalt jacket was sealed fast with a coat of asphalt paint, as well as being stapled with 2-in. coppered hoop staples. Over the asphalt jacket was applied a covering of Mulehide insulation fabric. This fabric was sealed fast in all its joints with a coat of asphalt paint, as well as being stapled for strength so that the entire insulation was absolutely impervious to water. The covering for the high pressure lines, while being 3 in. thick, made up of two 1½-in. layers, was applied in exactly the same manner. After the covering was applied, inspection was made of the line to make sure that supporting saddles and rollers were securely in place at intervals of from 12 to 15 ft. according to the size and weight of the line.

Side forms for the conduit were built of matched pine lumber and made up into panels about 12 ft. long by nailing the pieces which were 1 in. thick, and 6 in. wide to 2 by 2-in. nailer strips, as is shown in Fig. 2. The inside side forms were set against the shoulder in the base as is shown in the sketch, and the top held by the roof boards which were made of 1-in. lumber, not matched. As the side forms were set, the return line supports which were made and welded in the field, were placed in position. These supports are approximately 15 ft. apart. Before placing the tops on the forms but with the side forms set, the return line was placed in position, welded and tested. The top boards were then nailed on and covered with tar paper or roofing felt to keep the water from the concrete from oozing through the inside of the conduit. Where it was necessary, due to the soil formation, steel outside forms were used, as is shown in Fig. 3. These outside forms consisted of ¼-in. steel plates, 3 to 4 ft. wide and 12 ft. long. These plates had two ' U'' bolts welded to the top edge to facilitate placing and removing by means of chain blocks. These forms were held in place along the top by tie braces.

Where the soil was of hard pan formation, these outside metal forms were omitted, the trench being dug narrower and the walls protected by roofing paper so that the soil would not be washed into the concrete while pouring. No attempt was made to remove the inside forms after the concrete had been poured.

Concrete used for the conduit was made of 1-2-4 mixture, thoroughly mixed to a quaking mass and thoroughly rammed into place. The average thickness of the walls was 5 in., and of the top 6 in. The top was reinforced with expanded metal, Steelcrete, 3-4-45 being used. With few exceptions it was possible to spout the concrete directly from the mixer into the ditch, the top and side walls being poured at the same time. For this purpose a special hopper and spout was designed and built so that the concrete was conveyed from the mixer into place in the conduit with minimum loss. The rough aggregate and sand were placed advantageously along the trench so that they could be easily conveyed to the mixer. Water for the mixer was obtained from fire plugs or private taps as conditions required.

Expansion Joints and Pipe Fittings

Expansion joints used in the low pressure line were of the standard 125 lb. slip type with anchor but without

FIG. 3. SOIL FORMATION NECESSITATED USE OF STEEL FORMS IN THIS LOCATION

service and were made with 8 in. of traverse. Tees and crosses were standard C. I. 125-lb. type with anchor base. The companion flanges were made of rolled or forged steel and were welded on nipples approximately 18 in. long in the factory before shipping to the field. All flanged joints were made up with corrugated copper gaskets and the bolts used were heat treated so as not to lose their elasticity under high temperature. The high pressure expansion joints were electric cast steel duplex sleeve type, with 8 in. of traverse, packed with flexible metallic packing. These joints did not have the guide feature, but were equipped with monel studs and bronze nuts for drawing down the packing gland; the guiding of these joints was taken care of by placing alinement guides approximately 5 ft. and 35 ft. in front of the joints. One anchor lug was cast integral with the body of these joints; the other lug being welded on as required on the job. The ends of these joints were beveled so that they could be welded into the line on the job. All expansion joints were equipped with safety stops on the slip end.

Tees, crosses, elbows, were welded up as required. The 400-lb. pressure valves were made of steel by the Chapman Valve Co., and also had beveled ends so that they could be welded into the line, thus eliminating all flanges. The fittings used in the return line were of cast iron, 125-lb. standard.

Manholes used in this work were of rather large dimensions and many difficulties were encountered in the construction of these as is shown in Fig. 4. The walls were made of brick, 12 in. thick, and there is head room of at least 6 ft. in every manhole and 20 in. side wall clearance from expansion joint body. At this height

FIG. 4. MANHOLE UNDER CONSTRUCTION

the holes were railed over and two hatch holes were built up to the surface and supplied with two manhole covers. It was usually arranged so that one manhole cover would be at each end of the manhole, allowing for sufficient light and ventilation. Ladder irons were supplied for easy entrance and exit in these manholes. All exposed fittings in manholes were thoroughly covered with block covering and plastered to a thickness of 2 to 3 in., depending upon whether they were in the high or low pressure line.

Mains which were installed during 1925 were the result of careful studies of load conditions and general steam consumption tendencies of Rochester and in several of the larger cities of the country. The steam load of every prospective consumer was carefully estimated and a tentative location for the new steam plant was chosen. When the Lawn St. site had been decided upon the work of routing the distribution system was begun.

Location of all known obstructions, such as water pipes, sewers, gas pipe, telephone and electric conduits, were obtained from the city engineering department, gas and electric corporations, and telephone company. The sizes of the high and low and return lines were calculated to take care of the present and future requirements. With these sizes known, the most economical arrangement of the pipes in the conduit was determined which fixed the over-all dimensions of the conduit.

Much study had to be given to this pipe arrangement so that at points where fittings were required there would be sufficient clearance for the flanges and at expansion joints, repacking could be done easily. This latter point was taken care of to a considerable extent by staggering the joints so that the glands of the joints in the various pipes were not in line. With the physical controlling factors known, a route was selected which would afford the best mechanical operation of the system and which could be constructed in a congested district to the least inconvenience to the adjacent property owners and general public.

Storage of excavated dirt and materials of construction is a big problem in any congested district. When piling of dirt in the street would cause unreasonable hardships to business or general traffic, this material

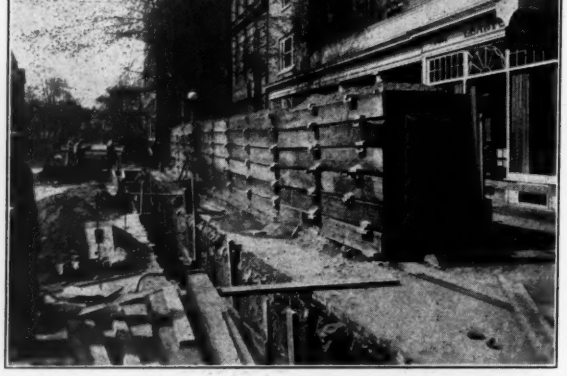


FIG. 5. IN SOME LOCATIONS CRIBS WERE USED FOR STORING DIRT

was hauled away to a spoil bank as excavated and then rehauled for back filling. Where circumstances allowed, an ingenious system of cribs, as shown in Fig. 5, was used for dirt storage. By special arrangement with construction material vendors, this material was delivered just as required and was immediately used and placed in the ditch. Where traffic or business was particularly congested and there were no dwellers to be disturbed during the night hours, the major operations were carried on at this time.

Load Factor an Index of Operation

IT MAY DETERMINE THE DIFFERENCE BETWEEN PROFIT AND LOSS IN AN ICE PLANT. BY HARRY L. SEMANS

LOAD FACTOR should not be confused with power factor as it has to do only with the relationship between the demand created and the amount of power consumed and, to a certain extent, can be determined by the operator. Various power contracts exact different penalties for poor load factor and there are but few under which a saving cannot be made by maintaining a high load factor. In many cases the actual saving effected in the power bill will mean only a few dollars per billing period but if a low load factor is brought about by careless and inefficient operation, the loss in production of the ice plant means the difference between profit and loss to the owner.

Regardless of the period covered in the contract, or between meter readings, the operation for each period should be determined in advance and the operation laid out and followed as closely as possible. In other words, operation should be as consistent as possible between billing dates. The object should be to keep the maximum demand as low as possible on the equipment to be used during the period, rather than to build up the total consumption to make a high load factor against a high demand. Should some unfortunate circumstance cause a high demand to be created during the period and, except for this, the plant was being operated at a high load factor, it would not pay to try to build up to this demand. It would be better to take the penalty.

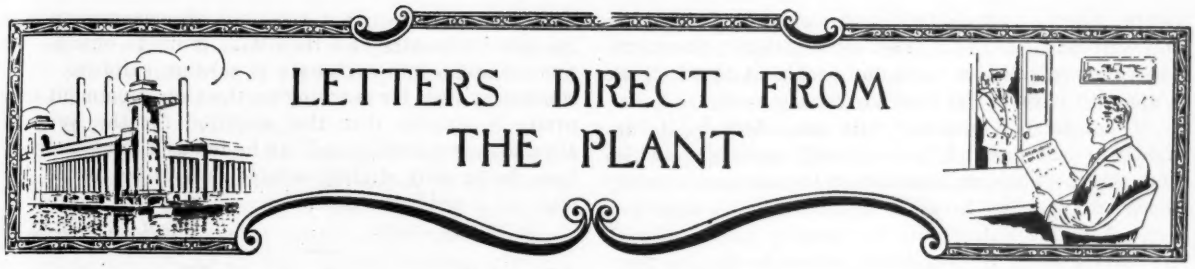
ACTUAL OPERATING FIGURES EMPHASIZE IMPORTANCE OF CAREFUL OPERATION

To illustrate, take an ice plant operating under a special ice plant rate in effect in one of the large cities. This plant starts a monthly period under full operation of two ice making units and all auxiliaries, creating a demand of 500 kw. If a 90 per cent load factor were made under this contract, in a 30-day period 324,000 kw-hr. would be consumed at a cost of $3243 or $.010009 per kw-hr. An 85 per cent load factor would show a consumption of 306,000 kw-hr. at a cost of $3127, or $.01022 per kw-hr.; 80 per cent load factor consumption, 288,000 kw-hr. at a cost of $3001, cost per kw-hr., $.01042; a 75 per cent load factor 270,000 kw-hr., cost $2875, or $.01065 per kw-hr.

In the foregoing it will be noted that the cost per kw-hr. increases as the load factor decreases. The load factor can be made low by operation of one compressor intermittently, extreme changes in head pressure or back pressure, etc. Applying the cost per kw-hr. earned at 90 per cent load factor to the consumption under the other load factors given above, it is found that at 85 per cent load factor a loss of $64 is sustained in the power cost, at 80 per cent a loss of $119, and at 75 per cent the loss is $173.

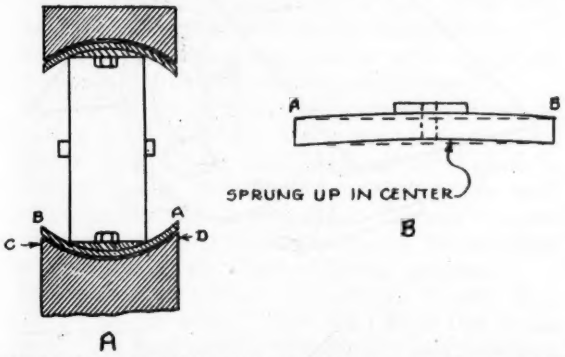
Should the preceding losses be sustained through careless operation and not through unavoidable circumstances, they would be well worth investigation but they would be small compared to the loss in production. Assuming an average of 50 kw-hr. consumed per ton of ice made, under a 90 per cent load factor, 6480 t. would be made in the period. At 85 per cent load factor, 6120 t.; at 80 per cent load factor, 5760 t., and at 75 per cent load factor, 5400 t. The cost per ton for power at 90 per cent would be $0.05005, at 85 per cent load factor $0.511, at 80 per cent $0.521, 75 per cent $0.5325. If the average selling price of ice were $5 per ton the loss in revenue would be as follows: 85 per cent load factor $1800; 80 per cent load factor $3600; 75 per cent load factor $5400. Deducting the additional power cost from the foregoing sums, there still remains an amount worthy of consideration.

If demand meters are used by the power company, the load factor is easily checked from the power bill or through information obtained from them, and such checks should be made on each bill received.



Cast-Iron Guide Shoes Spring. Why?

In the illustration are shown the guides, shoes and cross head of a 20 by 24-in. engine, at 204 r.p.m., giving a piston speed of 816 ft. per min. This engine is of the enclosed crankcase type, oiling the crankpin, reciprocating parts, main bearing and eccentrics from the crank case by the splash system, the oil level in crank case being kept so that the crank disk runs ¾ in. in oil. A thermometer, attached to the crank case, shows its temperature, which, when the engine is running, averages 120 deg. F. Guides, which are cast as part of the frame,



SECTION OF CROSS HEAD AND GUIDES. B. DETAIL OF SHOE WHICH SPRUNG IN THE CENTER

are bored to a circle, the radius being 9 in. The shoes are made of cast iron and the crosshead of cast steel.

Stepping from the engine room for about five min., I returned to find a cloud of smoke and lots of noise issuing from the crank case.

On shutting down, the shoes were found sprung up in the center lengthwise with the corners A and B sprung towards the guides. Plenty of oil was in the crank case at the time, no dirt, grit or water in it and oil had been renewed 60 days before.

This is the second time this has happened in 3 yr. and I cannot understand why.

Metal piled up on the guides and the shoes were badly scored. High spots on the guides were so hard that neither file nor scrapers could make any impression, so they were ground down with a portable emery grinder and the whole smoothed up with a lead lap, using emery flour and oil on the lap. It was not bad work smoothing up the bottom one but 55 lb. of lead was no joke when working on the top guide. We made the lap by cutting pieces of wood to fit the circle of guide, set them in and poured the lead in till even with the top as at C and D.

Shoes were turned up in a lathe and when assembled 0.015 in. clearance was left between the top shoe and the guides. No babbit is used in these guides, the shoes and guides running cast iron to cast iron.

When this engine was first bought and before it was run, we cleaned the whole inside of the cast-iron parts of the frame and crank case with wire brushes and steel wool, gave it a good washing out with gasoline and then applied two coats of orange shellac. Oil, after being used for a considerable length of time, will show scarcely any discoloration as compared to that usually seen in an engine not treated that way. It is also easier and more quickly cleaned than others, as the inside is almost as smooth as glass.

Minneapolis, Minn. Fred S. Rutledge.

Power Plant Architecture

For some reason the appearance of power plants has received but scant attention from engineers, although those who have traveled in Europe cannot possibly have escaped having the subject brought forcibly to their attention. These impressions are, however, often superficial, especially when mixed with hundreds of others, so that the subject has remained dormant until uncovered by the recent article in Power Plant Engineering. It is hoped that, with the ball started rolling, definite results and increased co-operation between engineers and architects will be forthcoming.

Both professions have been prone to consider their work as basic and that of the other as subsidiary so that the problem lies in evolving a method by which they can work on an equal basis, without either feeling that it is dominated by the other.

For large central stations, the work of the engineer must precede that of the architect, who must take the engineer's arrangement and transform it into a presentable structure. Sub-stations are not so definitely limited by mechanical requirements so that the comparatively small buildings may be conformed to the style of the locality.

It becomes a question as to where the item of added expense for architectural improvements can be charged and this may best be answered by clipping from an investment bulletin which quotes an interview with Judge Voorhes.

' I like to study the items of a balance sheet of a public utility with which I am acquainted; for example, 'Station, grounds and buildings, $290,000.' This is an attempt by arithmetic to describe these buildings.

"But see a broad, brown river, a level place set about with trees, a high green hill rising behind it. The buildings are of grey slate, warm red bricks and white stone. The waters in the reservoir are shining in the sun. The driveways are marked with whitewashed

stones, which is an old-fashioned way, but green grass and whitewash are the cleanest combination in the world. The entrance gates are open and people sit about on the grass with never a '$5 fine' to stumble over.

"Contrast this property with one which by its unsightly appearance and the unfriendly atmosphere which pervades the whole organization of the company actually repels people. Its 'invisible balance sheet' is legal tender. A public utility with its treasury empty of such currency may, with confidence, expect to find its regular balance sheet and income account seriously affected, so close do the visible and invisible infringe upon things material."

Such a statement coming from the financial department of a large utility company shows that engineers are at last realizing the value of beauty in a power station to the community in which it is situated. Landscape gardening is also important for the fact remains that the good will of the public is an important item for public utilities and a station which adds to the general appearance of a city is a source of civic pride and has great advantage over one that is not. To secure favorable judgment by the general public, the exterior of a station is quite as important as the interior and equipment.

Certainly the same reasoning applies to industrial plants as well for factories with attractive power plants are likely to have the rest of their equipment in good shape, to pay attention to the needs of their employes, and to maintain an organization which looks after working and health conditions. Such an industry with the support of the community, which it will gain, cannot help but come out on top.

Los Angeles, Calif. B. MARKER.

Water-Purification for Ice Making

I READ WITH interest the article, Water Treatment for Raw Water Ice Plants, by W. N. Waterman, July 1, 1926 issue. It was quite instructive, but he failed to mention the use of alum for water purification which is, I believe, a new development. After the treatment with lime there is still left about two to three grains per gallon of calcium and magnesium carbonate which make the water alkaline. The treatment with alum neutralizes, or destroys this alkalinity and in so doing converts the calcium carbonate to calcium sulphate which is less objectionable since calcium carbonate leaves a deposit in the ice and sediment in the ice box when the core ice melts.

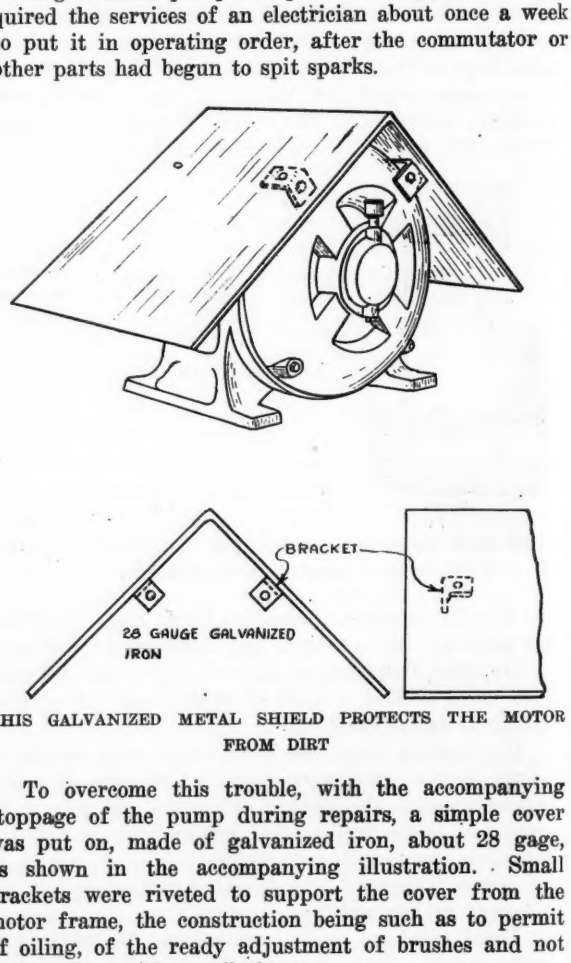
Another advantage of the alum treatment is that generally a lower brine temperature can be carried without the ice having a tendency to crack or shatter. When alum is introduced into an alkaline water a jelly-like precipitate is formed. This collects any finely divided particles of suspended matter in the water into large enough aggregates to be removed by settling and filtration. This scouring or clarifying process is valuable where the water is turbid or highly colored as the color is much lessened. It is practical to use the alum treatment alone and dispense with the lime treatment where the water treated has fairly small amounts of calcium carbonate.

Where the water contains a considerable quantity of calcium or magnesium carbonates it is best to treat first with lime to reduce to a minimum the magnesium and calcium carbonates and then with alum to change the remaining calcium carbonate to calcium sulphate. The equipment used for carrying on the alum treatment naturally is simpler than that required for the lime, as alum dissolves readily and can be fed as a solution while lime, being only slightly soluble, has to be fed in the state of a uniform suspension.

Coleman, Texas. GERALD SWANN.

Metal Covering Protects Electric Motor

WHEN AN electric motor is in an exposed location on the shop floor, or on a low stand, dirt chips and tools falling on it may do more damage than years of service. In one plant we had an excellent 5-hp. motor, driving a small pump of open frame type, which required the services of an electrician about once a week to put it in operating order, after the commutator or other parts had begun to spit sparks.



THIS GALVANIZED METAL SHIELD PROTECTS THE MOTOR FROM DIRT

To overcome this trouble, with the accompanying stoppage of the pump during repairs, a simple cover was put on, made of galvanized iron, about 28 gage, as shown in the accompanying illustration. Small brackets were riveted to support the cover from the motor frame, the construction being such as to permit of oiling, of the ready adjustment of brushes and not to interfere with ventilation.

Washington, D. C. G. A. LUERS.

Exchange of Boiler Tube Caps Prevents Shut-Down

IT IS A known fact that as a rule, an excited man cannot think rapidly and clearly. Not long ago as I sat in the engine room lost in reverie, a fireman from a power plant across the street rushed in and shouted:

"Say Mister! My chief wants to know if you have a cap for a water-tube boiler."

Informing him that I did not, I asked him the reason for all the rush. He said: "We had boiler No. 1 all ready for the inspector and a tube split on No. 2. We got No. 1 together and had about 60 lb. of steam when a cap split so we can't run."

I asked him why he did not use a cap from boiler No. 2. He opened his mouth and a look of foolishness came over his face. "Gingo," he cried, "I guess my chief is so excited he never thought about that." Turning, he hustled out on the run. I noticed steam from the exhaust an hour or so later, and I afterwards learned, as I had surmised, that the caps on both boilers were the same size.

That engineer was capable enough in many ways but excitement had simply destroyed his power for reasoning clearly and quickly. After a few moments of normal thought, doubtless he would have arrived at the simple remedy which was right before his eyes.

Toronto, Canada J. E. NOBLE.

Auxiliary Boiler Equipment Is Valuable

UNDER THE ABOVE TITLE, in the September 1 issue, p. 969, J. E. Noble brings out another good point when he mentions the need of instruments for guidance in the boiler room. Not enough attention is paid to auxiliary equipment not primarily essential to operation.

In view of the fact that the purchase of even an indicating thermometer for feed water temperature undoubtedly will pay for itself over and over again in the saving of fuel, the engineer ought to go one small step further and make it a recorder. There is no doubt that once the manager has acquiesced to the purchase, he will not balk at the slight additional expense.

Every operator wishes to anticipate trouble since usually he has the alibi: "How did I know that would happen?" In most cases, a recorder acts as a forecaster to a wide-awake operator. It gives him an indication of approaching trouble. A slight change in the line of the chart record is sufficient to warn a watchful man that his operation has undergone a slight change.

To the manager, it prevents the shifting of responsibility from one turn to the other. The chart shows just when the trouble occurred and quite often points to the reason. This alone, in my opinion, warrants the additional expenditure.

While most plants have a pressure gage on their feed water lines, those that have not will find it useful. It is of particular value in carrying the best pressure differential between the feed water and boiler pressure, for the most dependable operation of the feed water regulators. In case of low water in the boilers, low pressure in the feed line often is the cause of the trouble, and immediate knowledge of the fact is valuable.

In particular, I know of one case where centrifugal feed pumps were located in the engine room a considerable distance from the boilers. Just when the load was heavy the low water whistle began to blow lustily and considerable time was wasted in locating the trouble. Finally we dashed into the engine room and found the feed pressure down.

The scare we had was sufficient reason for our putting a gage in the boiler room alongside the master steam gage, showing us at all times what feed water pressure we had. It would not have required much of a delay to have shut the plant down.

This also brings out the point that buying the instrument is only half the job. An instrument, no matter how high priced or valuable, is rendered practically valueless unless placed where it is conveniently visible.

I visited one plant that had an indicating thermometer on the feed line leaving the heater, but it was placed under the heater so that the water tender had to crawl on his hands and knees with a torch or flashlight to read it.

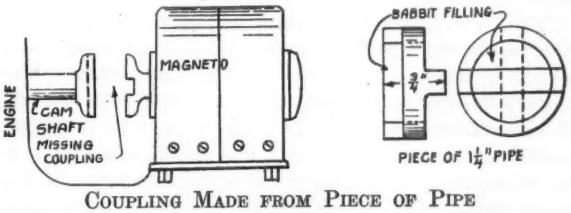
This same plant had a recording thermometer for steam temperature mounted on top of the boiler. The purchasing agent had attempted to economize or had failed to receive proper dimensions, and the lead was too short to reach from the steam line to the floor. Since the operator had to get up on the boiler to take readings or change the chart, I know for a fact that he did not see it often.

There is no reason why expenditure for instruments should be nullified by making it a burden on the operators to read them. Instruments should, if possible, be mounted on convenient, well-lighted gage-boards, centrally located, so that the operators will respect them and learn to appreciate the valuable information they give. They are purchased for the boiler man primarily, just the same as his other tools, and they should be put where he will be glad to use them.

Pittsburgh, Pa. C. W. STEVENS.

Home-Made Magneto Coupling Works

ON A ROAD building contract we use a portable compressor and engine; when not in use we take off the high



COUPLING MADE FROM PIECE OF PIPE

tension magneto. One day, when ready to replace it, we could not find the half-and-half filler which goes between the cam shaft and magneto disks; something had to be done quickly to get the engine and compressor working.

A piece of 1¼-in. pipe was cut off ¾ in. long, the two fitting parts traced with a center square, cut out with the hacksaw and finished with a file. In order to keep the quickly made coupling from slipping, the inside was filled with babbit and trimmed to fit. A week later we found the original coupling, but in the meantime our "home-made" was kept at work.

Death Valley, Calif. CHAS. LABBE.

Make Your Own Standard Soap Solution

IF YOU use an exchange water softener and are paying good money for a standard soap solution for testing and wish to reduce this expense, or you run out of soap solution you can use any liquid soap, standardizing it yourself by taking water from about the middle of the run of the softener and adding a common liquid soap until a good lather results, using the same amount each time. Or before running out of the standardized solution, check the new with the old.

Rochester, Minn. L. A. COWLES.

QUESTIONS AND ANSWERS

Tri-Sodium Phosphate Treatment for Boiler Feed Water

USING THIS agent for conditioning water we have one boiler entirely free from calcium as shown by the oxalate test for 10 da. but even as much as 10 lb. of additional phosphate shows no excess in the boiler, which holds 25,000 lb. of water. What becomes of the excess phosphate? P. P.

A. Adding sodium phosphate to water containing calcium carbonate will produce calcium phosphate, which is insoluble and precipitates, and sodium carbonate which will combine with water to an extent giving sodium hydroxide (caustic soda) and carbonic acid. The latter again breaks up into water and carbon dioxide.

Excess of sodium phosphate will hydrolize by a double reaction, forming sodium hydroxide and orthophosphoric acid. The sodium hydroxide from both causes will give a strong, alkaline reaction and unless care is taken in determining the phosphate content, it will not be found. Ten pounds of trisodium phosphate can easily be lost in 25,000 lb. of water.

Dr. R. E. Hall, in consultation, suggests that there may be old scale in the boilers, which is gradually dissolving and this may use up the excess of sodium phosphate. Once this old scale is all removed, the amount of phosphate needed to keep the water in condition would be materially less. He also points out that it is the concentration and type of acidic radicals in the water, rather than the amount of calcium or magnesium present, which determines bad scale forming conditions. If the proportion of the acidic radicals is maintained at a point based on the operating pressure of the boiler, the solid phases of calcium and magnesium cannot separate from the water to form scale.

Without doubt, addition of a sufficient amount of sodium phosphate will show an excess in testing the water but the amount to produce excess will be larger until old scale is gone than afterward.

As to the oxalate test referred to in the question, Dr. Hall says:

"If a large amount of calcium is in the water, it will precipitate when oxalate is added, giving an easily recognized cloudy appearance. If the amount of calcium is small, the cloudiness may be hardly noticeable and no precipitate may appear because of tendency to supersaturation. The ammonium oxalate test is also wrong because the amount of calcium which will produce cloudy precipitate in one water may be laying down no scale, while in another water calcium may not show a precipitate yet be laying down troublesome, adherent scale. This is because the amount of calcium needed to form a calcium solid salt, calcium sulphate for instance, varies with relation to acid radicals in the water, as previously stated.

Examiner's Questions for New York City

HEREWITH are presented the questions given recently in an engineer's license examination for New York City. It is felt that they will be a useful guide for those preparing to take an examination there or elsewhere; also trying to answer them satisfactorily will be an interesting test for any engineer to apply as to his knowledge of plant equipment and operation.

A prize of $5 will be awarded for the best set of answers received during the next month.

ENGINEERS' EXAMINATION QUESTIONS
NEW YORK CITY
ENGINE QUESTIONS

1. If, in starting a small engine, it turned over two or three times and stopped, what would be the cause?
2. How is a vacuum created? What is it? How is it used?
3. How would you find the clearance of an engine?
4. Tell how you would start an engine if it had been shut down for 6 mo.
5. What is the horsepower of an engine with 12-in. cylinder, 4-ft. stroke, at 100 r.p.m., and 60 lb. mean effective pressure?
6. How would you set a piston valve properly? How would you know that it was properly set?
7. Describe the valve decks of a pump.
8. How would you examine a check valve while the boiler was being fed?
9. What would you look out for when removing the plunger from a feed pump?

BOILER QUESTIONS

10. What material is used for boiler tubes? Why?
11. What is the meaning of spacing of braces?
12. How is the size of a safety valve determined?
13. What are grooving and pitting? What are the causes?
14. Are riveted or welded seams better for boilers?
15. What is wire drawing and what is the cause?
16. What are the comparative rates of combustion for natural and forced draft?
17. Explain the operation of a surface blowoff valve.
18. Describe grate bars with which you have had experience.
19. Where is the steam pipe connected to a water tube boiler? To a locomotive boiler? To a horizontal boiler? To a vertical boiler? Why?
20. Describe a blowoff tank and name the connections from the boiler to the discharge pipe from the tank.
21. How would you find the horsepower of a boiler? Illustrate, using your own figures.

22. How would you determine the size of the feed pump needed from the heating surface of the boiler?

23. Describe how a steam gage works and tell how you would care for it.

Methods of Ash Disposal

IN THE DISPOSAL of powdered fuel ash, what forms of mechanical conveyors have proven successful? Have screw conveyors been used in this work and, if so, have they been able to withstand the abrasive action of the ash?

Is it common practice to sluice the ash away?

W. L. T.

A. In most cases the drag conveyor, the pivoted elevator and the simple gravity method of dumping ash direct into railroad cars or industrial cars have proved to be the most satisfactory from a mechanical standpoint. The screw conveyor has not been used to any great extent for ash handling on account of the great abrasive action of the ash. This abrasive action must be considered with any type of mechanical conveyor but with the screw conveyor it seems to be greater than with the others. The screw conveyor, however, is often used in the modern pulverized fuel plant in certain parts of the coal preparation.

Sluicing of ash from powdered coal furnaces, is coming rapidly into favor, especially in some of the larger plants. One manufacturer of ash handling equipment now has on the market a complete hydraulic method of sluicing ash by the use of water jets which is applicable to plants of almost any size. Many of the larger central stations have adopted the sluicing method, among them Twin Branch, Philo and Columbia. At these plants the ash drops from the ash hoppers into an open sluiceway running along under the boilers which carries it out into an ash storage tank from which it is pumped for filling purposes by special manganese steel ash pumps.

Acid Treatment of Feed Water

IN OUR plant near Houston, the well water is quite alkaline as the following analysis shows:

Substance	Gr. per Gal.
Organic matter	0.17
Silica	1.01
Iron oxide and alumina	0.67
Magnesium carbonate	0.56
Calcium carbonate	1.06
Sodium bicarbonate	10.13
Sodium sulphate	2.78
Sodium chloride	4.17
Total	20.53

Is there a reliable method of treating this water with sulphuric or other acid to neutralize the alkalinity? How should such treatment be regulated? A. K. E.

A. Assuming that the water is for boiler purposes, as the analysis shows high in alkaline salts, it will be possible to neutralize the alkalinity with sulphuric acid, the degree of neutralization depending upon the boiler pressure.

In view of the fact that there is danger of caustic embrittlement with such a water, steps for establishing a definite ratio between sodium sulphate and the sodium carbonate should be taken. This relation, as established by the sub-committee of the A. S. M. E. Boiler Code Committee, is as follows:

Working Pressure of boiler lb. gage	Relation of Sodium Carbonate Alkalinity	to Sodium Sulphate
0 to 150	1	to 1
150 to 250	1	to 2
250 and over	1	to 3

As sulphuric acid would not only neutralize the alkaline salts but also provide for the necessary sodium sulphate through the chemical reaction, the commercial acid (sp. grav. 1.84) is advised.

In order to obtain the desired sulphate-carbonate ratio in the boiler water, for the different operating pressures, the following reduction of alkalinity is necessary.

Operating Pressure lb.	Reduction in Alkalinity gr. per gal.	Lb. of Acid per 10,000 gal. water
0 to 150	10.13 to 6.75	3.02
150 to 250	10.13 to 4.73	4.82
250 and over	10.13 to 3.62	5.79

Serial Report (1924-1925) of the Prime Movers Committee, N. E. L. A., on the Treatment of Feed Water gives the detail of the Acid Feeding System at the Calumet Station of the Commonwealth Edison Co.

With the best of proportioning systems for handling sulphuric acid, it is advisable to have a laboratory check on the sulphate-carbonate relation. We know of no method sufficiently accurate for checking this method in the field and it has been our experience that, unless an accurate method is used for checking an acid treatment, there is great danger of trouble.

CYRUS WM. RICE & CO., D. C. CARMICHAEL.

Treatment should be in tanks, if possible, which will hold a 30-min. supply, the tanks to be ventilated and water aerated to remove carbon dioxide which will be formed.

If tanks are impossible, some device must be used to proportion the acid to water flow. At the Beacon St. plant of the Detroit Edison Co. this is controlled by differential pressure from passing the water through a venturi tube. The difference in pressure acts on a mercury U tube and a float regulates the orifice in the acid tank.

Lime and calcium sulphate have been proposed as treatment for such waters, added as a milk. Lime is to precipitate the sodium bicarbonate and calcium sulphate to react with sodium carbonate. Water should be filtered after treatment. To prevent formation of caustic soda, a possible source of embrittlement, magnesium sulphate has been suggested. Overdose of this would result only in added soft sludge which could be removed by extra blowdown. Alum is another possible agent but is somewhat expensive. Any of these treatments would be free from the danger of corrosion in piping and boilers which would result from an over supply of sulphuric acid.

Acid treatment is the simplest and, if the operating force is competent and conscientious, would be satisfactory. Frequent tests of the boiler should be made, however, as well as of the raw water and acid carefully proportioned. It would be desirable to have conditions checked at frequent intervals by a competent chemist.

EDITORIAL COMMENT

Combustion Tendencies

From firing run of mine as she came, lumps to dust, to complete pulverization followed by gasification and burning the gas is a long step and leads to a conjecture whether the end of our pulverized fuel practice is to be the combustion engine, eliminating steam. Attempts have been numerous to accomplish this via the gas producer but growth in the size of units needed and improvement in steam making and use have kept steam stations to the front.

Now comes the development,—thus far experimental and for boiler fuel,—of a process to pulverize, gasify and deliver a gas, mostly carbon monoxide, to the boiler furnace. But why not to the gas engine cylinder?

Experiments which involve a unit pulverizer of 1200 lb. an hour capacity and a boiler of 1200 sq. ft. heating surface, at 107.5 lb. pressure and 56.5 deg. F. feed temperature, show 8.49 lb. evaporation from and at 212 deg. per pound of a fuel having 11,493 B.t.u. heat value, 6.33 per cent moisture and 14.78 per cent ash. This is 9.07 lb. evaporation per pound of dry fuel and 11.48 lb. per pound of combustible. The thermal efficiency was 76.2 per cent.

Consciously or not, research tends to faster and more complete oxidation of fuel in large quantities. It is in keeping with other industrial progress which seeks rapid methods and large output. Pulverizing and gasifying are in line with this tendency. The question is what means will best utilize the hot gases, combustion engine, gas turbine or the added step of the steam cycle. The answer seems to lie in the realm of materials available and mechanical design.

Apprenticeship Courses Should Develop Brains

Too often we hark back to the days when a tradesman spent the years of his youth as an apprentice to a master workman, with the feeling that mankind and industry is deteriorating into a condition of carelessness and slipshod workmanship. Unfortunately too many of the manufactured articles on the market today may be characterized as made to sell and have not the enduring qualities of articles made by the hands of a master workman from carefully selected materials.

Industry, however, does not require the same percentage of skilled tradesmen that it did when everything was handmade. Nails are no longer laboriously hammered out by hand; the file is not used in making screws; polishing and lapping are now jobs for machinery. Quantity production of almost every product manufactured is almost wholly by machinery with the aid of assemblers specialized for their particular jobs. The physical skill developed by long years of training as an apprentice is demanded of but few workmen in our industries today.

More and more, modern industries are seeking men who are trained to think, to reason, to calculate, to meet emergencies as they arise, to plan changes in methods and conditions and to predict results, to devise ways for substituting machinery for the more expensive hand labor. So the need of today is for apprenticeship courses designed to train the mind to a greater extent than the hand.

Steam power was a pioneer in relieving the backs of men of their heavy burdens. Since its application, one after another of the physical labors of men have been taken over by machinery until the most delicate machine work is now done automatically. The entire power plant industry is built up around the desire of mankind to be relieved of irksome physical labor and surrounded with comforts in daily life. People prefer to develop their physical bodies by pleasant exercise rather than by arduous labor. We must admire the skill of the fireman who keeps his fire in perfect condition but, as stokers are fast replacing hand-fired grates, his physical skill will find a narrowing market, as has been the history in many of the trades for which long apprenticeships were required.

Apprenticeship courses are still necessary in industry but we do not need them as a system to train men for work which can be better done by machinery.

Distribution Real Problem of Rural Electrification

Rural electrification is rapidly passing through its early experimental stages, gradually being molded into a dependable central station load. Unfortunately the successful solution of the problem bears little relation to production problems, which have heretofore been the object of the major portion of experimental and practical developments.

Because of the scattered location of the users, the fixed charges on the distributing lines overshadow the actual cost of power production. Close co-operation between the farmer and electrical company is a necessity in order to develop economical transmission and good load factors. On the basis of a mile of line costing $1500 serving four farmers per mile, the fixed charges at a conservative rate of 18 per cent will cost each farmer about $5.50 a month whether he uses power or not. An actual load of 225 kw.-hr. at a cost of 2c per kw.-hr. will therefore mean an energy charge of 4c and the problem is to teach the farmer to use power to advantage so that he will get an actual 4c value.

Transmission efficiencies are relatively unimportant. the load factor must be held up and the farmer taught to use kilowatt-hours to advantage in replacing manual labor as well as shown the necessity of co-operating with his neighbors in the use of his equipment, in order to avoid dangerous and unnecessary peaks.

Electrical men realize this and their efforts for co-operation are being rewarded in many sections. One large company has made plans to extend rural lines, paying for the lines themselves up to a certain amount and assessing the farmers for any expense over that amount. The farmers, in turn, agree to invest in electrical equipment a sum equal to the cost per subscriber of building the line. This should insure sufficient load to put the lines on a paying basis.

Continuity of service is another important consideration and a farmer depending upon milking machines and electric brooders might suffer considerable damage, if power were interrupted for several hours. Certainly this has been a factor in hindering extensions in certain territories but, as with early western telephones hooked up to use the barbed wire of the fences, even poor service is better than no service, if the farmer can be educated to use power to advantage where continuity of service is not so important.

Perfection of generating equipment and proper stand-by units have reduced the danger of outage from this source to practically nil. Storms can be guarded against by proper construction. The manager of one of the larger middle western public utilities states that experiments, carried on the last 3 yr., practically eliminate electrical disturbances on the system.

An intensive educational campaign modeled after the domestic appliance campaign is being waged by many companies on the assumption that distribution problems and load factors are not electrical and mechanical so much as they are individual and community problems of proper application and consumers' co-operation. Such campaigns should do much to increase the general use of our electrical systems in the outlying districts as well as being a step forward in farm production economy.

The Engineer and the Law

When we scrutinize, closely, the lives of the men who are most prominent and successful in our industrial and political activities, we soon discover that a surprisingly large number of them have, at some time in their careers, had experience or training in law. At first thought this may seem to be merely a coincidence. We are convinced, however, that there is a definite relation between their success and the fact that they have had training in law.

We are convinced, moreover, that training in the profession of law is valuable to a man for a reason that is seldom mentioned. Many people will agree that the lawyer gains, in the course of his work, a splendid insight into human nature, that he comes in intimate contact with men and events of importance, that he gains a knowledge of the details of the laws by which we are governed and is in a better position to help make others. These, however, are not the most important acquisitions of the student of law. The most important one, it seems to us, is the training he gets in thinking a subject through with clear, cold logic from beginning to end and then putting it into words in the form of a brief. Until ideas can be put into words, the ideas themselves are not clear in the mind, for it can be proved that thinking and writing (or speaking) are not two separate processes but only parts of one single process. Thus the man who can command his own thinking can usually command the thinking of others.

The advantage of this training in orderly, logical thinking is apparent when the lawyer or the student of law enters another field. It is impossible in this short space to mention typical examples. Every page of Who's Who contains them. They include men prominent not only in politics, where they might be expected to appear, but in great manufacturing industries, in great mercantile establishments, in every field of human endeavor, even in the arts.

With these ideas in mind, we were much interested to note the suggestion of a writer in the Journal of Engineering Education that the study of law be substituted for that of the higher mathematics (calculus) in engineering courses. He presents figures to show that only a small proportion of engineers ever use higher mathematics in practical work anyway. He also points out that the difficulty many engineering students have with the calculus is that they never can understand how an exact science can be based on an approximation. This gives rise to teaching difficulties which, the writer says, are too costly in proportion to their results. In short, he maintains that the sole justification for the teaching of higher mathematics to engineers is the mental discipline the subject affords.

Since this is admitted by many teachers, the above-mentioned writer proposes that law be substituted for the higher mathematics in engineering schools. In this way, he argues, the student will be getting the same or even more effective mental discipline but, more important than that, he will be equipping himself with a tool that has been of the greatest use to many men in carving out their careers. He wants the engineer to have a real law course under real professors of law, not a dilettante course in "Law for Engineers" or "Engineering Contracts," given by some young civil engineering instructor. He wants to give the engineer a tool which he can use every day of his professional career, instead of one that he will never need after graduation.

In view of the present interest throughout the engineering profession in such subjects as engineering education, the place of the engineer in modern life, the law of supply and demand as it applies to his remuneration, the lack of general education and culture in the profession and similar topics, we commend the above ideas to the consideration of every engineer. A little investigation will show him that there is a really definite connection between knowledge of the fundamentals of law and success in any walk of life.

CHARLES A. COFFIN, who set out in the '80's to sell electricity to the people, has had his faith amply justified by the great development of recent years. As late as 1912, Washington statistics show that electric light and power stations produced 14,000,000,000 kw-hr., while in 1924 this had risen to 60,000,000,000 kw-hr. Customers served rose from less than 2,000,000 in 1907 to 13,000,000 in 1924. Students of social conditions foresee the reduction of overgrown cities with their attendant problems of congestion, crime and transportation, through distribution of power to smaller centers, lessening the lure of metropolitan life.

POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS

Water Wheels Used to Drive Pumps

IN WATER WORKS and for driving pumps in processes where the presence of salt, water, chemical fumes or other conditions prohibit the use of electric motor drive, also where fire hazard is great, water-wheel driven pumps have, within the past few years, found a number of new applications.

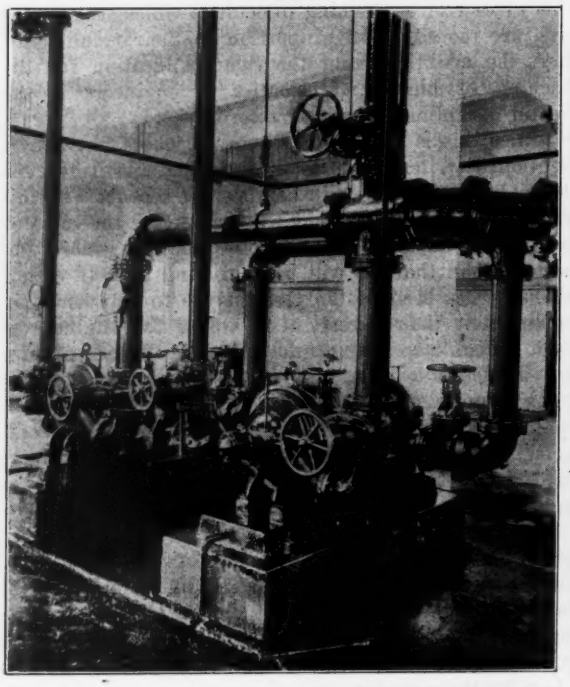


FIG. 1. WATER WHEELS DRIVE THESE WASH WATER PUMPS AT OMAHA

Figure 1 shows two such pumps, built by the Worthington Pump and Machinery Corp. and used in the plant of the Metropolitan Utilities District, Omaha, Neb., for supplying wash water to the filtration plant. Each unit consists of a centrifugal pump direct connected to a fixed-vane water wheel.

Careful analysis was made of costs of purchased power and generated power for motor-driven pumps. Water for driving the wheels is taken from the high-pressure mains, then discharged into the overhead wash-water reservoirs, so that no water is washed. A saving of $2500 a year over any other method of operation is estimated.

In the Poppleton Ave. boosting station of the same company, water wheels are used for driving circulating water and condensate pumps, as shown in Fig. 2; also in the main Florence station for driving circulating pumps for the steam condenser. In the Poppleton Ave. plant, two water wheels are connected in series, discharging into the low-pressure side of the water system, with a bypass connection so that part of the water from the condensate pump water wheel can be passed directly to the condenser. This provides independent speed control for the two water wheels.

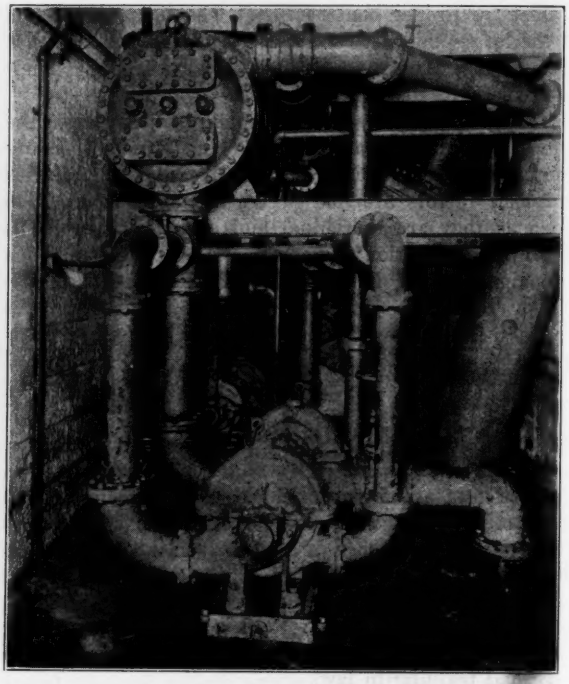


FIG. 2. CIRCULATING CONDENSER PUMPS ARE DRIVEN BY WATER WHOSE DISCHARGE ALSO GOES TO CONDENSER

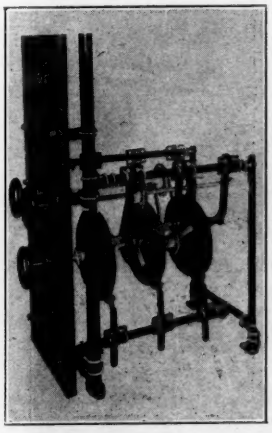
Fourteen water-wheel driven pumps are used in a salt factory at Wadsworth, Ohio, for handling brine solutions. Water for driving the wheels is from a Worthington centrifugal pump driven by a 400-hp. steam turbine which works between 135 lb. initial and 10 lb. exhaust pressures. Exhaust steam from the turbine is used in the evaporators, thus utilizing its latent heat.

BUNKER HILL monument was illuminated by electricity for the first time on the 151st anniversary of the famous battle it commemorates. The high shaft, now lighted by G. E. searchlights, may be seen far out at sea, and will be used as a beacon by aviators.

New Switchboard Wiring Developments

AMONG THE recent General Electric developments in the design of switchboard accessories are several new types of supports and arrangements. In addition to new arrangements for the support of group-mounted rheostats shown in Fig. 1, a complete standard line of indoor bus and cable supports for light, moderate, heavy, and extra heavy duty for flat surface mounting have been developed.

Where enclosed potential busses are desired, the method illustrated in Fig. 2 is of interest. Slip joints are being used on these fittings. As may be noted, conduit of different sizes is used with this arrangement,



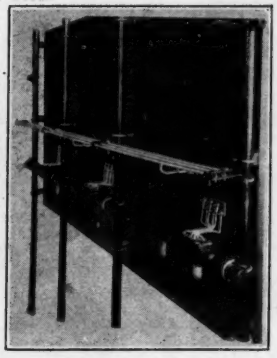


FIG. 1. MECHANISMS AND SUPPORTS FOR THREE GROUP-MOUNTED RHEOSTATS

FIG. 2. TWO METHODS OF INSULATING POTENTIAL OR SYNCHRONIZING BUSSES. UPPER SECTION OF BUS INSULATED WITH "HOPE BRAID." LOWER BUS ENCLOSED IN CONDUIT

the smaller size slipping into the larger size and fastening on to the condulet by means of a bushing and locknut.

Another new development is the use of square steel rods and adjustable supports for insulated wire in connecting up transformer banks.

Commonwealth Edison Orders Another Generator for Crawford

THE COMMONWEALTH EDISON CO. of Chicago has recently placed an order with the Westinghouse Electric and Manufacturing Company for a steam turbine unit of 104,000 kw. The new unit is to be installed at the Crawford Ave. Station, making a total of six turbine generators aggregating about 450,000 kw. Some three years ago the Crawford Avenue Station was started with three units of 50,000 to 60,000 kw. capacity each, two of American make and one of British make. Subsequently a 77,000-kw. and a 90,000-kw. unit have been installed. The new turbine generator will operate at 550 lb. gage pressure, 720 deg. total temperature and a 29-in. vacuum. The shipping weight of the turbine will be approximately two and one-half million pounds.

Arch Is Repaired with Plastic Refractory Gun

IN THE illustration is shown an arch repaired with plastic refractory, by use of the Quigley refractory gun, using a mixture of Hytempite and crushed old fire brick. This arch is in one of the plants of the Portland Electric Power Co., Portland, Ore., where hog fuel is burned in a setting of Dutch oven type, under one of their 400-hp. boilers. Combustion conditions are severe and play havoc with the suspended arches, so that repairs and replacements are frequent. By repairing

THIS SUSPENDED ARCH WAS REPAIRED WITH PLASTIC REFRACTORY BY MEANS OF A GUN AFTER FALLING AND EROSION HAD PENETRATED TO FROM 1 TO 10 IN. IN DEPTH

them in the manner shown, the life has been considerably increased, as shooting the refractory material into all the crevices brings the arch surface back to original alinement. The illustration shows the arch after having been in service several months. Before it was repaired, the spalling and erosion of the arch block over the bridge wall varied in depth from 1 to 10 in.

MASSACHUSETTS Department of Public Utilities has approved the petition of the Montaup Electric Co. for an additional issue of capital stock amounting to $3,500,000 with which the company plans to reimburse the Fall River Electric Light Co., the Blackstone Valley Gas & Electric Co. and the Edison Electric Illuminating Co. of Brockton, Mass., for advances made to the Montaup company for the construction of its power plant, transmission lines and equipment as well as to provide funds for a proposed addition. The Montaup company supplies the three companies named with electric current. Of the new issue, the Fall River company has been given permission to subscribe to 1761 shares and the Brockton Edison company to 4437 shares of a par value of $100.

THE PEOPLE'S MINNESOTA GAS & ELECTRIC CO., Minneapolis, Minn., operated by the W. B. Foshay Co., Minneapolis, has concluded negotiations for the purchase of the plant and system of the Henderson Light & Power Co., Henderson, Minn., and will operate in conjunction with its other properties. The new owner is said to have plans under consideration for expansion in the Henderson district, including transmission line construction.

N. A. S. E. Discusses Problems at Atlantic City

FORTY-FOURTH ANNUAL CONVENTION OF NATIONAL ASSOCIATION OF STATIONARY ENGINEERS DEVOTED TO DISCUSSION OF ORGANIZATION'S BUSINESS

ORGANIZATION OF A national employment bureau, extension of the merit system and information bureau, the possibility of affiliation of the N. A. S. E. and smaller societies, and a proposal to change the name of the organization were the most important topics of discussion at the 44th annual convention of the National Association of Stationary Engineers held at Atlantic City, N. J., September 13-17.

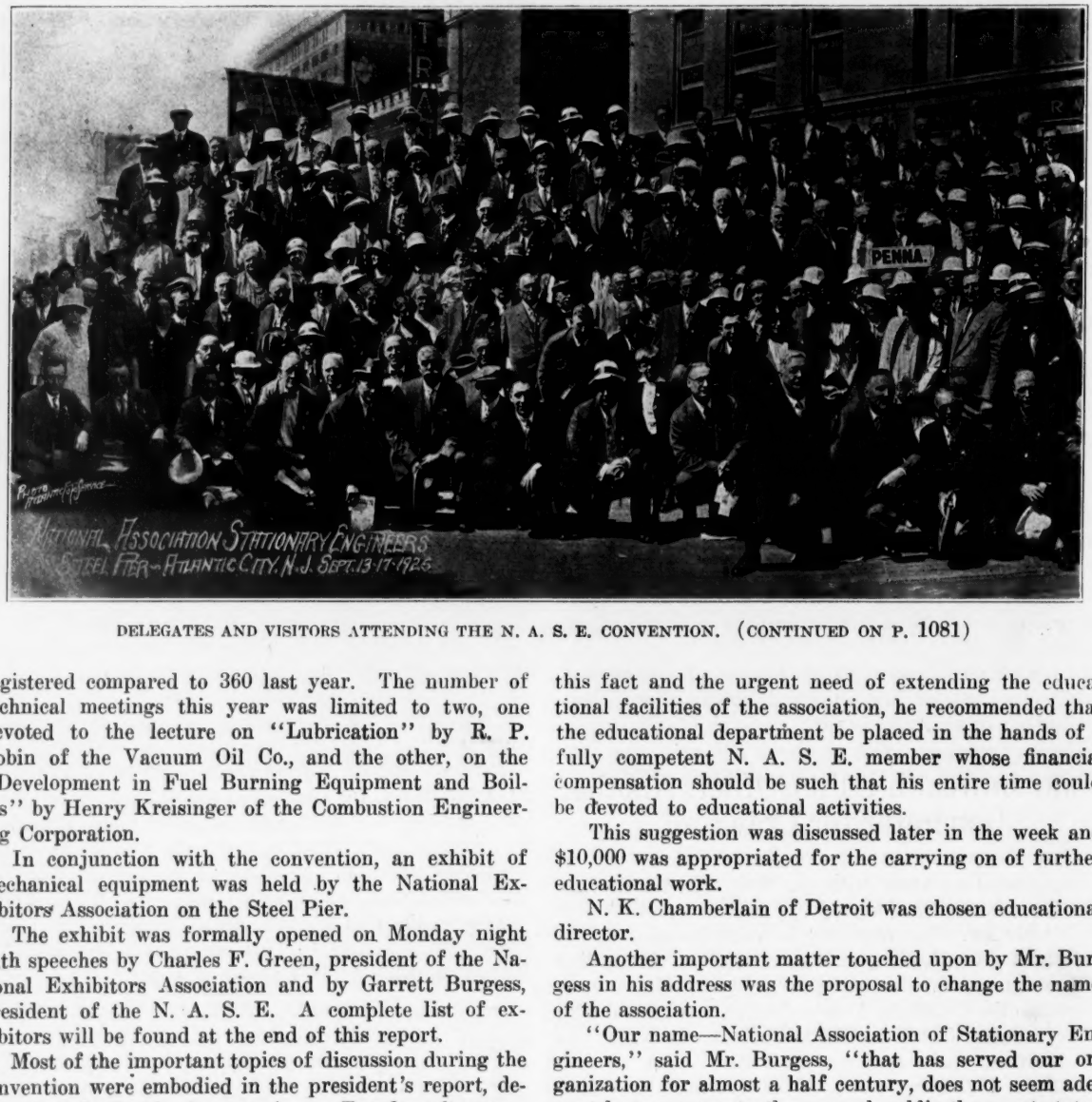
On the whole, it was a successful convention although in point of attendance it fell slightly below that held last year at St. Paul. This year 332 delegates were registered compared to 360 last year. The number of technical meetings this year was limited to two, one devoted to the lecture on "Lubrication" by R. P. Tobin of the Vacuum Oil Co., and the other, on the "Development in Fuel Burning Equipment and Boilers" by Henry Kreisinger of the Combustion Engineering Corporation.

In conjunction with the convention, an exhibit of mechanical equipment was held by the National Exhibitors Association on the Steel Pier.

The exhibit was formally opened on Monday night with speeches by Charles F. Green, president of the National Exhibitors Association and by Garrett Burgess, president of the N. A. S. E. A complete list of exhibitors will be found at the end of this report.

Most of the important topics of discussion during the convention were embodied in the president's report, delivered at the first business session on Tuesday afternoon, Sept. 14. In this report, Mr. Burgess stressed the fact that the N. A. S. E. is primarily an organization for the education of the power plant engineer, and pointed out that the work of the national and subordinate organizations had proved effective and a great many members owed their progress in the profession to the educational facilities offered them by the association.

The merit system, which was inaugurated just a year ago, has been of unquestionable value, Mr. Burgess stated, in giving progressive members an opportunity to advance in their profession. The general educational committee in charge of the work had proved its worth and all its members had given generously of their time and services, with no financial remuneration. In view of this fact and the urgent need of extending the educational facilities of the association, he recommended that the educational department be placed in the hands of a fully competent N. A. S. E. member whose financial compensation should be such that his entire time could be devoted to educational activities.



DELEGATES AND VISITORS ATTENDING THE N. A. S. E. CONVENTION. (CONTINUED ON P. 1081)

This suggestion was discussed later in the week and $10,000 was appropriated for the carrying on of further educational work.

N. K. Chamberlain of Detroit was chosen educational director.

Another important matter touched upon by Mr. Burgess in his address was the proposal to change the name of the association.

"Our name—National Association of Stationary Engineers," said Mr. Burgess, "that has served our organization for almost a half century, does not seem adequately to express to the general public the exact status of our membership. In the earlier days of our history the word "Stationary" fulfilled its purpose, for then the steam engineer was universally known as a stationary

DELEGATES AND VISITORS ATTENDING THE N. A. S. E. CONVENTION. (CONTINUED FROM P. 1080)

engineer. And then steam was practically the only source of power generation. But, today, with the multitudinous sources of power, it is the consensus of opinion that the word 'stationary' has become olsolete, and in no way expresses the scope of the organization.

"It is further felt that the use of the word 'stationary' has been the means of keeping from our ranks a great number of engineers employed in the power plant industry, because it indicated that our association was composed strictly of steam engineers; and, further, that if the association was appropriately named, these men in the electrical, refrigerating and other branches of engineering would be more than glad to become members of the organization.

"The majority of suggestions received call for the substitution of the word 'power' in place of 'stationary' and in checking up the laws of the states in which our organization has subordinate associations we find that there would be no objection to our organization being known as the 'National Association of Power Engineers'."

At a later session this matter was discussed and action will be referred to a referendum.

According to a financial report by trustee Joseph F.

DELEGATES AND VISITORS ATTENDING THE N. A. S. E. CONVENTION. (CONTINUED FROM ABOVE)

Carney of the board of directors, the financial condition of the association was sound and there was sufficient money available to meet necessary expenses. A condensed financial statement was submitted which estimated the revenue from all sources during the coming year and which also contained an estimate of the amount needed for various activities. Cash on hand was given as $26,717.00. Income from the National Engineer, $25,000.00. Per capita tax, $13,500.00. Subscriptions to National Engineer, $9500.00. Sales of supplies, charters, etc., $1650.00. Interest and miscellaneous income, $200.00, and income from Educational Committee, $3000.00. This made a total expected income from all sources of $79,567.00.

Against this, estimated disbursements came to $55,925.00, leaving available for mileage at the 1927 convention, the sum of $23,642.00.

The report of the national secretary, F. W. Raven, indicated a decrease in membership of 700. This was not considered serious in view of the fact that the per capita tax is increased. The active membership, as of August 31, was 18,556.

As stated previously, this year's convention sessions included only two technical meetings. At the Wednesday morning session, Robert P. Tobin of the Vacuum Oil Co. gave an interesting paper on "Lubrication." After dwelling briefly upon the importance of lubrication in power plants, Mr. Tobin explained the process involved in the production of various types of oils from crude oil and then discussed the principles of lubrication.

The lecture on Thursday morning by Henry Kreisinger on the subject of "Developments in Boiler Design and Practice," was extremely interesting and was delivered with the usual Kreisinger clearness.

Mr. Kreisinger explained the fundamental principles involved in the design of the Combustion Steam Generator and showed how, by producing a spiral path of hot gases and building a boiler around this spiral, efficiencies of 88 per cent were easily obtainable.

New Officers

Election of officers for the coming year was held Friday morning, the last day of the convention. The principal officers elected were as follows: For president, John Quincy Adams of Minnesota No. 3; vice president, Elmer L. Bassett of Hartford, Conn.; secretary, Fred. W. Raven; Treasurer, Samuel B. Forse.

Officers of the National Exhibitors for the coming year are as follows: President, Geo. Rowland, The Texas Co.; Vice Pres., Jacob Eige, Fisher Governor Co.; Treasurer, T. F. Boyle, D. T. Williams Valve Co.; Sec., F. N. Chapman, A. Leschen & Sons Rope Co. The Executive committee will consist of I. S. Pieters, Plibrico Jointless Firebrick Co., chairman; G. T. Ogden, C. E. Squires Co.; J. H. Allen, The Everlasting Valve Co.; John Throesher, John Roeblings & Sons and H. A. Burdorf, The Lunkenheimer Co.

The Exhibit of Mechanical Equipment

The exhibit held in conjunction with the convention was held on the Steel Pier at Atlantic City by the National Exhibitors Association, under the supervision of Charles F. Green of the Home Rubber Co., president of the association, and Frank N. Chapman of A. Leschen & Son Rope Co., secretary.

Exhibitors at the N. A. S. E. Convention

Allis-Chalmers Mfg. Co. Milwaukee, Wis.
Ames Iron Works.....Philadelphia, Pa.
Anchor Packing Co....Philadelphia, Pa.
Armstrong Machine Works.....
.....Three Rivers, Mich.
Ashton Valve Co.....Cambridge, Mass.
Atlantic Mech. Sup. Co.....
.....Atlantic City, N. J.
Atlas Valve Co.....Newark, N. J.
Baker Valve Co.....Minneapolis, Minn.
Beers & Company, F.....Newark, N. J.
Birch Mfg. Co.....Chicago, Ill.
Boig & Hill, Inc.....New York, N. Y.
S. F. Bowser & Co., Inc. Ft. Wayne, Ind.
Bridgman Company...Philadelphia, Pa.
Brooks Oil Co.....Cleveland, Ohio
Budd Grate Co.....Philadelphia, Pa.
Bussmann Mfg. Co.....St. Louis, Mo.
Calebaugh Self-Lub. Carbon Co.....
.....Philadelphia, Pa.
Chicago Chemical Co.....Chicago, Ill.
Chicago Faucet Co.....Chicago, Ill.
Chicago Fuse Mfg. Co.....Chicago, Ill.
Chicago Rhoepac Products Co.....
.....Chicago, Ill.
Jas. Clark, Jr. Elec. Co..Louisville, Ky.
Cochrane Corporation Philadelphia, Pa.
Combination Pump Valve Co.....
.....Philadelphia, Pa.
Connecticut State Association.....
.....New Haven, Conn.
George H. Conner.....Philadelphia, Pa.
Coyne & Delany Co.....Brooklyn, N. Y.
Crandell Packing Co....Palmyra, N. Y.
Crane Company.....Chicago, Ill.
Crane Packing Co.....Chicago, Ill.
Davidson Co., M. T....New York, N. Y.
Dearborn Chemical Co.....Chicago, Ill.
Detrick Co., M. H.....Chicago, Ill.
Detroit Stoker Co.....Detroit, Mich.
Deckman Power, Heat & Refr. Co....
.....Woodlynne N. J.
Jos. Dixon Crucible Co. Jersey City, N. J.
Dura metallic Corp....Kalamazoo, Mich
Duriron Co., Inc.....Dayton, Ohio
Elliott Company.....Jeannette, Pa.
Everlasting Valve Co. Jersey City, N. J.
Evertite Piston Ring Co..St. Louis, Mo.
(W. A. Zelnicker Supply Co.)
Fairbanks Company...New York, N. Y.
Fisher Governor Co..Marshalltown, Ia.
Flexible Steel Lacing Co...Chicago, Ill.
"Flexitallic" Gasket Co..Camden, N. J.
Ford & Kendig Co....Philadelphia, Pa.
J. B. Ford Company..Wyandotte, Mich.
France Packing Co.....Tacony, Pa.
Garlock Packing Co.....Palmyra, N. Y.
Garratt-Callahan Co....New York, N. Y.
Globe Kneadable Met. Packing Co...
.....Brooklyn, N. Y.
Greene, Tweed & Co....New York N. Y.
Hawk-Eye Compound Co., not inc....
.....Blue Island, Ill.
Himmelein & Bailey, Inc..Camden, N. J.
Hoffman Specialty Co., Inc.....
.....New York, N. Y.
The Hollow Center Packing Co.....
.....Cleveland, Ohio
Home Rubber Co.....Trenton, N. J.
Hoopes & Van Sant..Atlantic City, N. J.
Paul B. Huyette Co., Inc.....
.....Philadelphia, Pa.
Hyland Mfg. Co, W. J.....
.....Springfield, Mass.
Illinois Engineering Co....Chicago, Ill.
International Comb. Eng. Corp.....
.....New York, N. Y.
Jenkins Bros.....New York, N. Y.
Johns-Manville, Inc.....New York, N. Y.
Johns-Pratt Co.....Hartford, Conn.
The Keystone Lubricating Co.....
.....Philadelphia, Pa.
Kieley & Mueller, Inc..New York, N. Y.
A. Leschen & Sons Rope Co.....
.....St. Louis, Mo.
Liptak Fire-Brick Arch Co. Mexico, Mo.
The Lunkenheimer Co. Cincinnati, Ohio
John R. Livezey.....Philadelphia, Pa.
McLeod & Henry Co.....Troy, N. Y.
Metalweld Service Corp.....
.....Philadelphia, Pa.
National Engineer.....Chicago, Ill.
National Tube Co.....Pittsburgh, Pa.
Neemes Foundry, Inc.....Troy, N. Y.
Okonite Co.....Passaic, N. J.
Otis Elevator Co.....Philadelphia, Pa.
The Permutit Co.....New York, N. Y.
The Perolin Co. of America.....
.....Philadelphia, Pa.
Philadelphia Grease Co. Philadelphia, Pa.
Pioneer Rubber Mills..New York, N. Y.
Pitts & Kitts Mfg. & Sup. Co.....
.....New York, N. Y.
Plibrico Jointless F. B. Co. Chicago, Ill.
Powell Company, Wm..Cincinnati, Ohio
Power .....New York, N. Y.
Power Plant Engineering..Chicago, Ill.
Quaker City Rubber Co.....
.....Wissinoming, Pa.
Quigley Furnace Spec. Co.....
.....New York, N. Y.
Reliance Gauge Column Co.....
.....Cleveland, Ohio
Republic Flow Meters Co..Chicago, Ill.
Richardson Scale Co.....Clifton, N. J.
Riley Stoker Corp....Worcester, Mass.
Roebling's Sons Co., John A.....
.....Trenton, N. J.
Rooksby & Co., E. J..Philadelphia, Pa.
Roto Company.....Hartford, Conn.
Schiller, Nolan & Co..Philadelphia, Pa.
Sinclair Refining Co...New York, N. Y.
Sinterbas Mfg. Co.....Wyoming, Pa.
Sloan Valve Co.....Chicago, Ill.
Snap-on-Wrench Co..Philadelphia, Pa.
Southern Power Journal...Atlanta, Ga.
Squires Co., C. E.....Cleveland, Ohio
Standard Oil Co.....Newark, N. J.
Sugar Beet Products Co.....
.....Saginaw, Mich.
Sumet Corporation.....Buffalo, N. Y.
Surety Products Co....Cleveland, Ohio
Stoker Engr. & Sales Corp.....
.....Philadelphia, Pa.
The Texas Company...New York, N. Y.
Tide Water Oil Sales Corp.....
.....New York, N. Y.
Unishear Company, Inc. New York, N. Y.
United States Rubber Co.....
.....New York, N. Y.
Vacuum Oil Co.....New York, N. Y.
Vulcan Soot Blower Co.....DuBois, Pa.
Wagner Mfg. Co.....Cedar Falls, Ia.
Warren Webster & Co...Camden, N. J.
Westinghouse Electric & Mfg. Co...
.....East Pittsburgh, Pa.
Wickes Boiler Co.....Saginaw, Mich.
D. T. Williams Valve Co.....
.....Cincinnati, Ohio
"X" Laboratories.....New York, N. Y.

News Notes

BURKE ELECTRIC Co. of Erie, Pa., announces the appointment of E. I. Van Doren as district sales agent, with offices in the Times Bldg., Troy, N. Y.

HERBERT P. WILDER, formerly with the Coon De Visser Co., has been appointed as an active member of the O. E. Frank Heater & Engineering Co., of Buffalo, N. Y.

ANNOUNCEMENT IS made by the Bristol Co., Waterbury, Conn., of the opening of a branch sales and service office in the U. S. National Bank Bldg., Denver, Colorado, with H. T. Weeks in charge.

THE KIRK & BLUM MANUFACTURING Co. of Cincinnati, Ohio, has, through the purchase of an adjoining factory, doubled its plant facilities for manufacture of pneumatic dust collecting, ventilating and conveying systems.

THE TIMKEN ROLLER BEARING Co. announces the appointment of C. H. Johnson as engineer, service department. He will have direct charge of the installation of Timken bearings in automotive and industrial applications.

THE POWER PLANT EQUIPMENT Co. of Kansas City, Mo., has recently appointed Charles C. Phelps, 473 Getty Ave., Paterson, N. J., as representative to handle the Marley Superheater in New York City and Northern New Jersey.

CONTRACT HAS recently been let to the Ingersoll-Rand Co. of New York City for four 480-hp., six cylinder, 15 by 20-in. solid injection marine oil engines for installation in two oil-electric tugs to be built by the Panama Canal Commission at the Balboa Shops for service on the Panama Canal.

THE LADD WATER TUBE BOILER Co. of Pittsburgh, Pa., has recently appointed F. E. Fairchild as engineering manager. Mr. Fairchild has been associated with the Dwight P. Robinson Co. as a power engineer in charge of design on various large steam power developments.

CLAUDE F. CHARD, for several years Cleveland district sales manager of The Austin Co., was killed in an automobile accident on Friday, August 13. Mr. Chard was 37 yr. old, a graduate of Purdue University, Class of 1910, a member of Triangle Fraternity and a member of The Cincinnati Club of Cincinnati. Before his association with The Austin Company in 1918, Mr. Chard was with the Westinghouse, Church, Kerr Co.

THOMAS J. LUCAS, formerly with the North American Light & Power Co., has opened consulting engineering offices in the Illinois Merchant Bank Bldg. of Chicago, Ill. Mr. Lucas was graduated from the University of Wisconsin in the electrical engineering class of 1907. He was employed by the Laclede Gas Light Co. in the Electric and Gas Departments, later became associated with William A. Baehr, Consulting Engineer, as chief engineer until 1923, since which time he has been chief engineer of the North American Light & Power Co., and of its subsidiaries, the Illinois Power and Light Corp. and the Missouri Power and Light Co. His work for William A. Baehr consisted in the handling of valuation and rate problems and directing the construction of plants under the management of this company. While chief engineer of the North American Light & Power Co., he had under his charge the design and construction of the new Des Moines Power Station and the Tecumseh Power Station of the Kansas Power and Light Co., also the gas plants at La Salle and Centralia, Ill.

THE KUHLMAN ELECTRIC Co., Bay City, Michigan, has recently opened an office at Atlanta, Ga., located in the Glenn Bldg., which will be in charge of Ernest K. Higginbottom. During the past 2 yr. Mr. Higginbottom has represented this company throughout the Southeast. Previous to that time his headquarters were at the main office and factory.

THE LAKE SHORE POWER Co., Toledo, Ohio, operating the Toledo & Indiana Interurban Co., Toledo & Indiana Transportation Co., and other power and traction utilities, has been acquired by Henry L. Doherty & Co., New York, operating the Toledo Edison Co., and numerous other light and power properties in Ohio and different states. The purchase was made, it is said, for a sum in excess of $2,000,000. The Doherty company will consolidate the various interests with its different properties, and plans for expansion and improvement. Charles T. DeMore has heretofore been president of the Lake Shore company.

THE EDISON ELECTRIC ILLUMINATING Co., Boston, Mass., has started a program of expansion at its Edgar generating station, Weymouth, Mass., to be carried out over a period of months. The entire work will cost close to $5,500,000, and will bring about an enlargement to double, approximately, the present capacity of the plant. Considerable additional equipment will be installed with increase in line facilities. The present station represents an investment of about $14,000,000, making a total sum of close to $20,000,000, as the cost of the plant upon completion of the current program.

EDWARD M. GRAHAM, president of the Bangor (Me.) Hydro-Electric Co., has purchased the Millinocket & East Millinocket Electric Co. at Millinocket, Me., which supplies light and power for these two paper manufacturing towns. It is proposed to supply the new plants with power from the Bangor plant at a later date but for the present the Diesel engines will be continued in use.

THE BANGOR (Me.) Hydro-Electric Co. has purchased the power site and dam of the International Paper Co. at West Enfield, Me., and a $2,000,000 development project will be carried out there. The company plans to start the installation of a 3500-hp. water wheel and generator next season, to be followed with a 5000-hp. unit and ultimate development to 15,000 hp., according to President Edward M. Graham.

THE PUBLIC SERVICE ELECTRIC & GAS Co., Newark, N. J., has placed the fourth generating unit in service at its new Kearny generating plant, effective August 27, developing a station capacity of 165,900 kv.a., and will continue to operate all four plant units under this gross

rating. The new generator has a capacity of 43,750 kv.a. Work is being pushed on the completion of the plant, and the fifth and last unit is expected to be ready for regular operation in the near future. This unit has a rating of 39,300 kv.a., bringing the station output to a maximum of 205,100 kv.a. Since the first of the year, the company has advanced its generating facilities by 118,050 kv.a., or more than one-fourth; by the close of the present year, with further increases soon to be available, the output will be approximately double that at this same time 5 yr. ago.

THE ST. JOHN POWER CO., St. John, N. B., a subsidiary of the International Paper Co., 100 East 42nd St., New York, will proceed with the construction of a proposed hydro-electric power project on the St. John River, Grand Falls, N. B. The work will consist of a power dam above the Falls, a tunnel under the town and a generating station below the Falls. The initial plant will be equipped for a capacity of 60,000 hp., divided into three units each of 20,000 hp. rating.

In co-operation with the Fraser Companies, Ltd., another paper mill organization, a large storage reservoir will be constructed on the Madawaska River, an important tributary of the St. John River. The output of the new plant will be used at two new paper mills to be constructed in this district by the International company, and at the corresponding plant of the Fraser Companies, Ltd., to be located in this same section. The entire project, including paper mills, as well as transmission lines and substations, is expected to cost upwards of $25,000,000. A. R. Graustein is president of the International company.

WORK IS being started on a central power station near Cardin, Okla., by the Commerce Royalty and Mining Co. This plant will furnish power for all the lead and zinc mines owned and operated by this company in northeast Oklahoma. In the plant will be installed three 2250-hp. Nordberg Diesel engines. At present this company has a compressed air plant at this location which consists of three Worthington air compressors each having a capacity of 2500 cu. ft. per min. These compressors furnish all the company mines and they have about ten miles of pipe laid. This compressed air plant has been in operation for the last year.

INSTALLATION WORK has recently been begun by the Oklahoma Gas & Electric Co. of the second unit of their plant at Harrah, Okla. This will consist of one 20,000-kw. Westinghouse turbine, served by a Wheeler Condenser, and one 1000-hp. Edge Moor water-tube boiler which will be fired with pulverized coal. At present this plant has one 15,000-kw. Westinghouse turbine and four 1008-hp. Edge Moor water-tube boilers which are fired by stokers. This installation work is in charge of company engineers and W. J. Brown is chief engineer of the plant.

THE TOWN OF FALMOUTH, Mass., has awarded contract for the construction of water works for the town to Vincent Calabrese & Son of Milford, Mass.

THE KENTUCKY UTILITIES CO., Louisville, is continuing extensions and improvement in its properties, and has recently taken over the West Kentucky Electric Power Co., operating in Hopkins and Union Counties; work is nearing completion on a new transmission line extending from Paducah to Earlington, and will be placed in service at an early date. This line will serve a portion of the territory heretofore securing power from the acquired utility. Immediate plans of the Kentucky Utilities Co. include the construction of a new power substation at Madisonville, with the building of a 33,000-v. transmission line from this station to other points; construction of a transmission line between Fredonia and Greenville, as well as other power line extensions in this district; and the installation of new pumping equipment in the waterworks station at Shelbyville, Ky.

CONTRACTS HAVE been awarded by the Central Maine Power Co. for a modern three-story brick office building at Green and Bradbury Sts., Augusta, Me., which will house the general offices of the company. Completion of the building is called for by June next. The general offices of the New England Public Service Co. will also be located in the same building. The Morton C. Tuttle Co., which has handled the Gulf Island hydro-electrical development for the company, will erect the office building. Walter S. Wyman is president of the Central Maine and the New England companies.

THE STATEN ISLAND EDISON CO., St. George, Staten Island, N. Y., operated under the direction of the J. C. White Management Corporation, 43 Exchange Place, New York, has authorized the immediate construction of a new addition to its steam-operated electric power plant at Livingston, N. Y., forming part of an expansion program inaugurated a number of months ago. The work will include the installation of a 15,000-kw. turbo-generator, boilers and auxiliary equipment, and estimated to cost approximately $1,340,000. A contract for the generating unit has been given to the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., and awards for other apparatus will be made in the near future. It is expected to have the extension ready for service next spring. The company recently increased its capitalization from 120,000 to 200,000 shares of stock, and has secured permission to issue 20,400 shares of stock, the proceeds to be used in connection with the plant expansion. The project will be carried out under the direction of the White organization. C. S. Banghart is vice president and general manager of the Staten Island company.

BROOKLYN POLYTECHNIC INSTITUTE, Brooklyn, N. Y., announces that a course of twenty 2-hr. lectures will be given every Friday night at the Institute, 99 Livingston St., beginning October 1. These lectures will be supplemented by class-room exercises and laboratory work in charge of Mr. Kuttner, who has handled the work in previous years. Lectures are fully illustrated by lantern slides, with special emphasis laid on the features of oil engines which distinguish them from other forms of power machinery, particularly from gas and gasoline engines. In the laboratory the single-cylinder engine available is assembled, dismounted, adjusted and tested under power in order to illustrate points made in the lectures. Students may enroll either for the lectures alone for one evening a week, or for lectures, class-room and laboratory which will take two evenings a

week, and may attend the first two lectures on October 1 and 8 without obligation.

THE MASSACHUSETTS INSTITUTE of Technology has recently announced the establishment of a field station at the Tide Water Oil Company's refinery at Bayonne, N. J. For several years the Chemical Engineering Department has been conducting through the school of Chemical Engineering practice an important part of its graduate training in chemical engineering at field stations located at Buffalo, N. Y., Bangor, Me., and Boston, Mass. Six plants are now co-operating with the Institute in conducting field work in chemical engineering. The field work for the students consists principally of plant investigations of the normal production processes and tests of the regular plant equipment. This work is being carried on in close co-operation with the Technical Staff of the plants and much of it is done on problems at the specific requests of the executives of co-operating companies.

WORCESTER (Mass.) Polytechnic Institute has announced a plan for the establishment of industrial research laboratories for concerns throughout Worcester County. Its plans, it states, will not interfere with the work of commercial laboratories nor engineers. Engineering problems, voltage, gas engineering, construction and other subjects will be treated.

AMERICAN BROWN BOVERI Electric Corporation of Camden, N. J., announces the opening of four district offices as follows: New York City, 165 Broadway; Chicago, 230 S. Clark St.; Boston, 842 Summer St.; Philadelphia, 922 Witherspoon Bldg.

MAJOR HOWARD SHARP BENNION, former assistant chief engineer of the Federal Power Commission, has been appointed Director of Engineering at N. E. L. A. Headquarters to succeed Colonel William Kelly, who left September 15, to become vice president of the Buffalo, Niagara & Eastern Power Corp., in charge of engineering and operation.

ANNOUNCEMENT is made by the United States Civil Service Commission of a competitive examination for junior engineers. Eligibles will be given the option of the following subjects: Architectural engineering, chemical engineering, civil engineering, electrical engineering, mechanical engineering and mining engineering. This examination is to fill vacancies in various branches of the Government service where vacancies exist. The entrance salary in the District of Columbia is $1860 a year, which is advanced with service up to a maximum of $2400. Further information may be obtained from the United States Civil Service Commission, Washington, D. C.

COMPETITIVE EXAMINATIONS are announced by the United States Civil Service Commission, for positions as architectural draftsmen, $225 a month; electrical engineering draftsmen, $200 a month; structural engineering draftsmen, $225 a month; topographic draftsmen, $200 a month. Applications for these positions must be on file in Washington, D. C., not later than October 19. The examination is to fill vacancies in the Panama Canal Service and positions requiring similar qualifications. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C.

Books and Catalogs

DIESEL ENGINES by David L. Jones, U. S. N., New York, $5.00 net. Following the opening statement that, "This book was written and compiled with the object of presenting to the practical operating engineer the elementary principles, care and operation of the Diesel engine," the first part of the book is developed logically, reflecting the author's experience as instructor in the Navy Submarine school and as an engine operator. The text is clear and concise with well chosen, simple illustrations.

Short chapters on elementary theory and principles with a comparison of various types of engines with other prime movers are followed by several excellent chapters on details of construction, lubricating and circulating water systems, indicator cards, testing and operating. Properties of lubricating and fuel oils are covered briefly and 26 pages devoted to "200 Diesel Engine Pointers."

Approximately one-third of the book is devoted to representative types of engines, going into the details of construction of various makes. Diesel electric drive for ships, Lloyd's marine rules and a reprint from "Lubrication" describing the 1000-hp. German submarine Diesel, cover in a general way the application to marine work while a chapter on the railroad locomotive, although mostly a miscellaneous collection of previously published material, describes the different types and collects in one book important information regarding the operation and application of the latest field to be successfully entered by the Diesel engine.

"A FURTHER INVESTIGATION of the Performance of Centrifugal Pumps When Pumping Oil" is the title of a report by Prof. R. L. Daugherty covering experiments carried on in California for Goulds Pumps, Inc., Seneca Falls, N. Y. Oils of various viscosities were handled by the same pump showing a decrease of head, capacity and efficiency and an increase of horsepower as the viscosity of the oil increased. Other experimental data and pipe orifice coefficients are included.

WHEELER CONDENSERS and their accessories, together with other Wheeler products are completely and interestingly described in a new 88-page illustrated bulletin issued by Wheeler Condenser & Engineering Company, Carteret, N. J. The text discusses first the fundamental characteristics of all condensers then describes the various types of direct flow, single and two-pass condensers and the diverted water flow two-pass condenser. Care and upkeep of surface condensers are discussed. Design and construction of Wheeler circulating and condensate pumps are also treated with many data on operation and maintenance. Sections are devoted to various types of jet and barometric condensers, jet air pumps, vacuum pump, condenser supports, expansion joints and cooling towers. The bulletin forms in effect a practical and up-to-date treatise on the modern condenser.

THE BAILEY METER CO. of Cleveland, Ohio, has just issued bulletin No. 43 descriptive of its steam flow-air flow meter used as a guide in boiler operation. This bulletin gives not only detailed information on the construction and operation of the Bailey boiler meter but also considerable information on the subject of combustion. Application of the meter to give complete and

accurate knowledge of the load being carried by the boiler, the combustion efficiency, also the condition of the boiler heating surface and baffles is fully explained. A number of illustrations show the application of these meters to pulverized coal, oil and gas-fired boilers, as well as to forced-draft underfeed, natural-draft chain-grate and forced-draft chain-grate stokers. Operation of steam-making can be as systematically and intelligently controlled as electrical generation, if suitable equipment is installed and properly used.

THE BORDEN CO. of Warren, Ohio, has recently issued a folder dealing with its new No. 70 Series Beaver adjustable die stocks, which are to be placed on the market on October 1.

JOSEPH HARRINGTON CO. f Harvey, Illinois, has just issued a catalog describing the King Coal Automatic Mechanical Stoker for small boilers running in capacity from 40 to 250 hp. This stoker has been developed to solve the smoke problem in large cities where soft coal is the principal fuel used in apartment, office building and hotel boiler rooms.

THE RYAN SYSTEM of Automatic Combustion and Temperature Control is described in a catalog just issued by the F. J. Ryan Co., Wesley Building, Philadelphia, Pa. By means of this system it is claimed that combustion is so regulated that set temperatures can be maintained in any industrial or commercial heating operation where oil or gas is used for fuel.

SMOOT ENGINEERING CORP., New York City, in bulletin No. 28, describes and illustrates the details of the Smoot Control of Combustion for Traveling Grate Stoker Fired Boilers. The outstanding feature of this control system is the provision that is made for separate control of each of the air zones of traveling grate stokers in addition to the usual control for fuel feed, dampers and the like.

JENKINS BROTHERS, New York City, in bulletin Form 107, pust published, describes and illustrates the use of the Jenkins Automatic Equalizing Stop and Check Non-Return Valve. This valve, designed to be used on each one of a battery of boilers, is used to equalize pressures and cut out a boiler that may be under lower pressure than others from various causes such as tube ruptures, low fire and the like.

BACHARACH ENGINE INDICATORS, Maihak Type, are fully described and illustrated in Bulletin 261, recently issued by Bacharach Industrial Instrument Co. of Pittsburg, Pa. This bulletin also describes the type of instrument developed especially for indicating oil engines. It also includes a description of the latest development which is the Maihak high speed indicator suitable for speed up to 2400 r.p.m.

RECORDING VOLTMETERS is the subject of Catalog 1502, Voltmeter Section, recently issued by The Bristol Co. of Waterbury, Conn. The catalog is well illustrated with half tone cuts and line drawings which give a clear idea of the appearance and construction of Bristol voltmeters. It is pointed out that these instruments have been used to advantage with transformers on high voltage alternating current systems, recording primary voltages with suitable transformers at power house, recording secondary voltage at customers premises, voltage output from emergency storage batteries and incoming voltages at manufacturing plants. These instruments are designed primarily for general commercial use. They can, however, be supplied with adjustable movements which also make them adaptable for laboratory purposes.

HALL-WILL, INC., Erie, Pa., in a well-illustrated 12-page booklet, describes the new Red-E-Hall portable electric pipe threading machine. This bulletin is accompanied by a price list as of July 1, 1926.

IN A BULLETIN just issued by the Drying Systems, Inc. of 1800 Foster Ave., Chicago, Ill., are described the Phoenix Constant-Effect Air Filter, and the National Rotary Air Filter, both of which are now handled by the one concern.

AUTOMATIC ARC WELDING APPARATUS is made the subject of bulletins GEA-452 and GEA-453, recently issued by the General Electric Co. of Schenectady, N. Y. The former deals with welding head and accessories, and the latter with semi-automatic welders.

BURY COMPRESSOR CO., Erie, Pa., in its new bulletin No. 408, describes and illustrates the Bury three-cylinder universal variable volume duplex 2-stage compound compressor, equipped with the Bury variable-volume unloading system and arranged for direct-connected synchronous motor drive.

LOCK JOINT PIPE CO. of Ampere, N. J., is distributing an interesting pamphlet dealing with the desirable features of its cylinder pipe which in reality is a welded steel pipe entirely encased in reinforced concrete, giving to it the desirable elasticity of a continuous steel cylinder, a high degree of water tightness, a great amount of strength and freedom from fracture.

BULLETINS Nos. 110 and 150 respectively, covering the new types HTD and HTA instruments manufactured by the Roller-Smith Co., of 233 Broadway, New York, has recently been issued, the outstanding features of these two instruments are that they are small enough for the pocket, tool kit or traveling bag, they are sufficiently accurate for all ordinary tests, and rugged enough to stand extremely hard service.

COXE TRAVELING GRATE STOKER is made the subject of a Catalog C-4, recently issued by the Combustion Engineering Co. of New York City. In the introduction to the catalog it is pointed out that the first successful forced draft traveling grate was designed and built some 25 yr. ago by Eckley B. Coxe, an owner and operator of anthracite mines. Today over 200,000 rated hp. of boilers are equipped with these stokers burning coke breeze. The catalog is well illustrated to show details of construction and contains results of tests which have been conducted with these stokers.

MUELLER STEAM SPECIALTY CO., INC., of 502 W. 126th St., New York, is sending out its new catalog No. 22 in attractive form with cover gold embossed on leather finish stock. Inside, the catalog is as informing as the outside is attractive. Instructions on how to specify and order steam specialties are followed by complete descriptions, illustrations and price lists of the company's product, including pressure reducing and regulating valves, relief valves, pump governors, strainers, steam and air traps, float valves and water feeders. The valves are made for steam, water, air, gas and oil and of types to handle pressures from low vacuum up to 200 lb. gage.